The Geological History of Hyderabad State with Special Reference to Its Mineral Resources

by

KHURSHID MIRZA, B.Sc. (Durham), C.E., M.I.M.E., M.M.G.I.,
Director of Mines and Geological Survey

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BULLETIN No. 2

(Revised and Enlarged)

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PREFACE.

It is due to the far-sighted policy and able stewardship of the Rt. Hon'ble Sir Akbar Hydari Nawab Hydar Nawaz Jung Bahadur, *Kt.*, P.C., LL.D., Finance Member, that the Geological Survey Department has kept on a steady progress for the last fifteen years of its existence and is carrying on a complete systematic survey of the State with special attention to its mineral possibilities.

The Department has been in a position to gather a mass of first-hand information which may be found scattered over its journals already published and under publication as well as in its unpublished reports.

There are records of information by foreign observers and Geologists to be found locked up in various old publications not easily accessible to the public.

Besides, we have come to know of many mineral occurrences from private sources and are often receiving enquiries from the public regarding information for some mineral or the other.

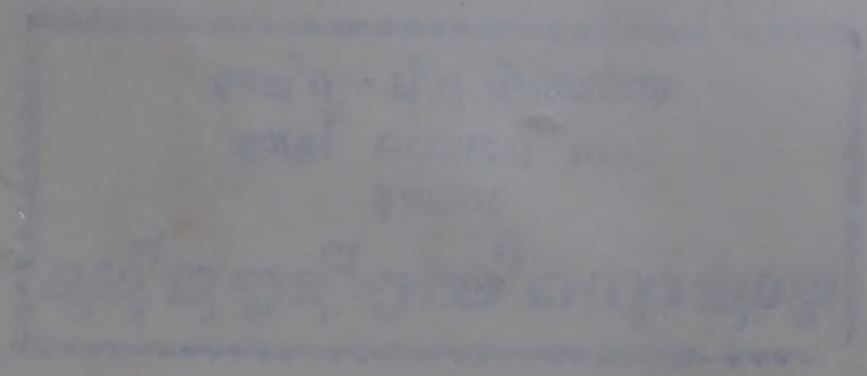
A need has therefore been felt to publish a pamphlet in a bulletin form incorporating, in brief, an outline of the geological history of the Hyderabad State with a special reference to its mineral resources, which it is hoped, will meet the present growing requirements of the public.

My sincere thanks are due to all the officers of the Geological Survey Department who have co-operated with me in preparing this paper.

I am indebted to the many private Companies for the statements of figures of output and value taken from their reports, to whom my thanks are also due.

K. MIRZA,
DIRECTOR OF MINES &
GEOLOGICAL SURVEY
DEPARTMENT.

HYDERABAD-DECCAN,
2nd January 1937.



PREFACE.

(Second Edition, revised and enlarged).

The war has greatly exercised the public mind for industrial development of the mineral resources of the State.

The first edition of the Bulletin No. 2 (Hyderabad Geological Series) having been exhausted, a revised edition is now being issued to meet the increasing public demand.

With the progress of the survey work of the Department a large amount of additional first-hand information has been introduced to make the publication up-to-date.

A Geological Map showing the distribution of the mineral resources of the State has also been incorporated.

My thanks are due to Dr. A. M. Heron, who very kindly looked through the Section III of the manuscript and gave valuable suggestions.

K. MIRZA,
Director of Mines and
Geological Survey Department.

Hyderabad-Deccan,
26th May 1943.

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CONTENTS.

A BRIEF OUTLINE OF THE GEOLOGICAL HISTORY OF HYDERABAD STATE WITH A REFERENCE TO ITS MINERAL RESOURCES.[1]

SECTION I.

Introduction.

The Hyderabad State of H.E.H. the Nizam lies between Lat. 15° 10′ and 20° 40′ N. and Long. 74° 40′ and 81° 35′ E., with an area of about 83,000 sq. miles and occupy a polygonal tract almost in the centre of the Deccan plateau. The average elevation may be taken as 1,200 ft. above mean sea-level with summits rising to 2,500 ft. to 3,500 ft. The State may be divided into two large and nearly equal divisions both geologically and linguistically distinct, separated from each other by the Manjra and Godavary rivers. The north and the western portions of the State are occupied by the Deccan Traps and inhabited by the Mahratta and Canarese speaking people, while the other portion forms mostly the gneissic complex inhabited by the Telugues.

Before dealing with the general geological history of the State a brief reference to the previous observers and the literature available on the subject may be made.

Minerals famous since proto-historic times—Gold.

The mineral possibilities of the Hyderabad State seem to have been realised from proto-historic times. The relics of ancient gold mines in Raichur district are supposed to date back to the time of Solomon. There is a theory that the

1. Opening Address: The Indian Science Congress, 1937, Geology Section.

Phœnecians worked these mines, another suggests Egyptian influence, and yet another school surmises that either the Chinese or the Indonesians had explored these mines as well as those in Rhodesia. In any case, mining activity in the State dates back to very ancient times.[1]

Historic Times.

We have very little connected record of mining activity in historic times, though, it is well known, that along the Kistna basin Diamond Mines were worked and some of the most famous old diamonds in the world such as Koh-i-noor, trace their origin to the so-called Golconda Mines. Tavernier[2] who visited India and parts of Deccan in the seventeenth century refers in detail to the diamond mining activity in the Deccan. The so-called Golconda Mines were all situated on the Kistna basin, and Golconda was the mart from where they were distributed.

The steel manufactured from the iron-ores of Nirmal and other places in historic times formed an important ware of merchandise between Hyderabad and other countries. The famous Damascus swords used almost exclusively this steel which went by the name of 'Wootz.' All these accounts are practically confined to the description of the mining activities or mineral products and contain little geological information.

Early Geologists.

From late 18th and early 19th century a number of geologists who were traversing the country on military duty or quasi-military duty have left accounts of their observations which form the earliest geological literature on the Hyderabad State. These are seldom more than mere travel sketches and very often inaccurate.

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1. Capt. L. Munn, Ancient Indian Gold Mining: Trans. Geol. Min. Inst. Ind. Vol. XXX, 1935.

2. For reference see end of Section I.

C. Mackenzie, 1794.

The earliest observer is Capt. C. Mackenzie[2] who in 1794 visited parts of the State, Cuddapah and Kurnool districts and recorded the results of his observations in Asiatic Researches Vol. V. His classification of the formations is erroneous. He refers to iron and diamonds being found in the same hill ranges, which is true to some extent.

B. Haynes, 1809-1814.

The next observer is Dr. Benjamin Haynes[3] who gave his observations on diamond mines of India. His description of the field geology of the diamondiferous area is fairly accurate but he does not go into the stratigraphic sequence or age of these beds. His paper on a journey in 1809 from Cuddapah to Hyderabad describes the general character of the rocks of the area of his traverse.

H. W. Voysey, 1819-1825.

Then comes Dr. H. W. Voysey,[4] Surgeon and Geologist to the great Trignometrical Survey of India. In several publications he has given an idea of the geology of parts of Hyderabad State. He recognised that granites covered the area in the neighbourhood of Hyderabad, Nalgonda, Medak, etc., and describes the individual characteristics of the granitoid gneiss of all these places and discusses the nature and origin of the Bidar plateau laterites (called by him iron-clay), and also makes a reference to the Traps of Tandur and Gulbarga. He falls into an error of considering bole beds in the Deccan Traps as being due to the decomposition of granites, and of considering all the dolerite dykes of post-gneissic period as genetically related to the Deccan Traps.

In 1825 the same observer published a paper on the diamond mines of South India. Belonging as he did to the Warnerien School of Geology, some of his observations were clouded by the prejudice common

to that group. But his descriptions of the actual observations are very accurate. With regards to the source of diamonds, his views are greatly correct. His conclusions were, (*a*) that the matrix of the diamonds produced in South India is sandstone-conglomerate formation, (*b*) that those found in the alluvium or soil are derived from the debris of the above rock, (*c*) that the diamonds found in the beds of the rivers were washed down by annual rains. The error of his correlating all the quartzite beds to the same horizon need not be detailed here.

Col. Sykes, 1833.

In 1833 Col. Sykes,[5] presented a paper before the Geological Society of London on the geology of parts of the Deccan. He failed to distinguish the low-level laterites from the high-level ones that form the summits of several tablelands in the Deccan Trap country. He did not recognise the existence of the schist series and considered almost all the formations as being true granites.

A.T. Christie, 1836.

The first general account of the Geology of Raichur and Gulbarga districts was from Dr. Christie,[6] who in 1836, gave an account of his observations which reveal his industry and acuteness. He too did not identify the schist series of the area and considered the gneisses as mostly granitic. The variations in the nature of granite gneisses as well as the quartz veins and trap-dykes that cut through these rocks, engaged his attention. In his attempt to correlate the geology from meagre data he sometimes falls into serious errors. He also regards the Dykes of the Peninsular complex as contemporaneous with the Deccan Trap.

Dr. J. G. Molcolmson, 1837.

Next in order of chronological sequence comes Dr. Molcolmson[7] of the Madras Establishment who in a few papers describes the geological features

between Hyderabad and Nagpur and of the South Mahratta country. Some of his observations are erroneous and his Geological Map of the area is far from even an approximation.

Newbold, 1836-45.

Capt. Newbold[8] between the years 1836 and 1845 wrote a series of papers on the Geology of South India including several tracts in the Hyderabad State and is universally acknowledged as the best informed and most accurate of all the earlier students of Indian Geology. His descriptions of Bidar laterite and of the country south of Gulbarga are correct and precise. In his account of the Geology of Raichur district, he recognizes the schist patches with the associated ferruginous quartzites near Tawargeri. His account of parts of Bijapur district and south-western portions of Gulbarga includes description of Bhima series of rocks. It is surprising to know that his estimate of the extent of the Deccan Trap in India is of the correct order of magnitude. He gives the probable extent as 250,000 sq. miles. With his characteristic acuteness he could distinguish the basic dykes of post-gneissic period as being geologically much older than the Deccan Traps.

Dr. Carter, 1854.

Dr. Carter[9] in 1853-54 tried to summarise the geological literature on India up to the period of the publication of his book. It contains very little original observation.

Col. Meadows Taylor.

Col. Meadows Taylor[10] in 1862-63 gave a description of the Geology of parts of Gulbarga district and his observations certainly do credit to an amateur who had no systematic training.

He is practically the last of the group of early observers on the Geology of Hyderabad State.

Geological Survey of India.

We now enter into the second era on the advancement of the geological knowledge of the Hyderabad State. The Geological Survey of India inaugurated in the year 1857 turned its attention almost immediately to Hyderabad State and from time to time the officers of the Geological Survey of India have given the results of their observations in the numerous publications of their Department.

Leaving aside the short traverse notes on parts of Hyderabad State from the officers of the Geological Survey, reference may be made to some of the major contributions in which some economically important areas in the State have been dealt with in some detail. The earliest of these is the memoir by King,[11] published in 1872 on the Cuddapah and Kurnool formations. In this memoir the sedimentary series of the Purana Group fringing the northern bank of Kistna river refer to the Hyderabad State. The memoir attempts at a review of the mining activities for diamond in the area and alludes to the iron that was recovered and smelted from the sedimentary formations.

The next important contribution from the Geological Survey of India is contained in Bruce Foote's[12] memoir on the South Mahratta country. He describes in detail the geology of greater part of Raichur Doab and parts of Gulbarga district. A brilliant and conscientious field geologist, Bruce Foote's contribution is naturally most illuminating and comprehensive, and is an example of what a memoir on such a subject should be. The revision work in the area by the Hyderabad Geological Survey has, however, brought out several discrepancies in the boundary and has also disclosed new formations of Dharwar bands not recognised by him.

The geology of the eastern coast from Lat. 15° to Masulipatam published in memoir XVIII[13] in the year 1879 refers to the eastern parts of the State. The next important contribution from the Geological Survey of India is the Report on the Pranhata-Godavary Valley by King[14] who in 1881 demarcated the boundary of the Gondwana formations and indicated the possibility of workable seams of coal.

In recent years Dr. Fox[15] has discussed the correlation of the Gondwana System in his memoir LVIII in 1931 and about Singareni and Tandur coal fields in memoir LIX published in 1934. Besides these important contributions, several traverse notes have been published by the officers of the Geological Survey of India. It should, however, be recognized that the areas in the Hyderabad State that attracted their attention are mainly regions of economic importance which fringe the British Indian districts. This constitutes but a very minor part of the total extent of the State. Detailed reference is not made to the contributions of the Geological Survey of India on the Geology of Hyderabad as the publications are easy of reach for any one interested on the subject.

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15. C. S. Fox.

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SECTION II.

From the sketch in the previous section it is clear that the geology of the State did not receive any systematic attention except for a few cursory traverses and notes, besides a few reports by the Geological Survey of India on some local areas which came under their purview in the usual course of their survey.

Inauguration of Hyderabad Geological Survey.

The State naturally felt a necessity for a systematic survey and first-hand geological information on the mineral resources. So, a department was inaugurated in 1331 F. with a very limited staff. The activities of this department, gradually increased and to meet this enlarged scope some additional hands were subsequently added.

Work of the Department.

During the first six years of its existence, the survey of the Asifabad, Nizamabad and parts of Nalgonda, Karimnagar and Atraf-i-Balda districts was undertaken. As most of these surveys were done on old Circar sheets and it was found when revision topographical survey was done, that the old sheets fell much short of accuracy with wide departures, it was considered inexpedient to publish the reports based upon the old maps, though the department was in a position to know the geology and the mineral resources of these districts covered by this survey. It is hoped that these reports will be published as soon as the maps are made ready on the revised topo-sheets now available.

With the publication of the revised topo-maps by the Survey of India, however, a systematic survey of the State was planned beginning with south-western corner of the State, i.e., Raichur district. The

detailed geological survey and the mineral resources of the Raichur Doab together with those of parts of Gulbarga, Mahbubnagar, Nalgonda, Osmanabad, and Warangal districts are now completed and these form the basis for the publication of the departmental Journals Vols. I, II, III, and IV, Bulletin Nos. 1 to 5. Others are in the press or under preparation.

The geological map of the State (vide map) is one which has been compiled from the work of the department and from other information available on the subject and does not claim to be an accurate map of the geology of the State as a whole. Nevertheless, this gives us a fair idea of the geological formations, their distribution, and the mineral resources of the State.

Area of the Geological Formations.

On the west and north-west, covering about half the area of the territory, the Deccan Trap rocks occupy about 35,000 sq. miles. The sedimentary series of the Gondwana formations and the transition rocks occupy about 12,000 sq. miles. The balance of about 37,000 sq. miles of the State is covered by the great Archæan Complex with subordinate runs of Dharwar schists distributed in them. About 1,150 sq. miles of the Dharwars have so far been mapped.

Broadly speaking, the geology of the State may be summed up in descending order as follows :—

Aryan Group.	1. Recent alluvium (Blown sand, Talus at foot of hills, moorum, black cotton soil, low level laterite and other soils.)			Recent.
	2. Older alluvials of Godavary, Tungabhadra, Kistna and Bhima rivers ; high-level laterites.			Pleistocene.
	3. Upper, middle and lower Deccan Traps with inter-trappeans and ash beds and infra-trappeans (Lametas?)			Upper cretaceous.
	4. Chikiala, Kota-Maleri beds	Upper Gondwanas.		Jurassic.
	5. Kamthi series	Middle Gondwanas		Triassic.
	6. Barakar series, Talchir Boulder beds.	Lower Gondwanas		Permian.
Purana.	Lower Vindyans.	Kurnools, Bhimas Sullavais.		Pre-Cambrian.
	Cuddapahs.	Pakhals		
		Penganga		

Great Epe-archæan Interval.

Vedic.	1. Peninsular Complex (Newer granites and gneisses). *Eruptive unconformity.*		Archæan.
	2. Older gneisses (C. F. Champion gneisses).		
	3. Dharwars.	Trappiod schists.	
		Hornblende schists	
		Chlorite schists.	
		Ferruginous Quartzites)	

As has been already pointed out, nearly more than half of the State is occupied by the various members of the archæan complex. The study of the archæan complex has particularly engaged the attention of this Department, not only on account of its mineral possibilities but also for academic interest. These series of rocks have been engaging the attention of the Indian Geologists who are trying to establish a correlation so to bring into harmony the various views expressed in different parts of India. The sedimentary rocks in the State have already received some attention from the Geological Survey of India in the course of their usual work and their observations are published in the Geological Survey of India memoirs and records. It is therefore felt expedient to give greater emphasis to the archæan complex of the State.

Dharwars.

Very small portion of this complex is, however represented by the Dharwars, the oldest recognisable rocks in the State. As can be seen from the map, the Dharwar schists are found in bands and irregular patches folded with the gneisses in a general north-north-west direction forming practically a northern continuation of the Dharwars of South India, in the Raichur Doab and in Surapur taluq, Gulbarga district. Other occurrences in Mahbubnagar and in Nizamabad districts have been noted. Areas, as yet unmapped have been reported at Nirmal extending into Nalgonda district, also in Karimnagar and Warangal districts.

So far as the State is concerned, the type area appears to be the Raichur Doab where the Dharwars have evolved in all their different igneous aspects.

The Department has bestowed detailed study on these Dharwars of Raichur and have established the intrusive relationship of the granites and granitic gneisses towards the Dharwar schists. There is a

consensus of opinion that all the constituent types of the Dharwars of this area are of igneous origin and that there is an absence of any facies of sedimentation. The survey has not disclosed any basement rock on which the Dharwars could nave been laid down.

Our study has indicated the igneous origin of the hornblende schists, chlorite schists and the epidiorites. The quartzites are the crushed phases of vein quartz, and the Dharwar conglomerates are of autoclastic nature. Slates, phyllites and quartzites are of sedimentary origin and limestones and conglomerates are conspicuous by their absence.

The study of the Peninsular Complex and their relation to the Dharwars and the origin of Dharwars have been the subject matter of controversy for the last decade or two and we have before us the opinion of Dr. Smeeth, Mr. Middlemiss, Dr. L. L. Fermor, Prof. Sampat Iyengar, Dr. Krishnan and Mr. B. Ram Rao of the Mysore Geological Survey. This Department is keenly alive to the line of arguments put forth by the astute archæan geologists.

Our work on the Dharwars of the State strongly falls in with the view expressed by Dr. Smeeth and Prof. Iyengar who have to their credit a life-long study of the archæans of Mysore.

Though accepting an igneous origin to the Dharwars of the Raichur Doab, we should not lose sight of some of the other Dharwar formations which have been reported but not studied in detail, where the sedimentary facies of the Dharwars with their ferruginous beds could be recognised. It is thus fortunate that Hyderabad State should form a linking ground where both the facies of Dharwars, viz., the igneous and sedimentary, should occur to throw light on the controversy of the genetic relationship of the

Dharwars. The late Prof. Iyengar in 1932 Congress, Bangalore, clearly expressed that in Mysore they were dealing with the igneous facies of the Dharwars, whereas, in the north, Singhbum and Central Provinces, typical sedimentary facies of Dharwars exist. He thought that there was no reason to give any one specific origin for all the Dharwars in India, neither is it possible. He made a prophetic statement that as they were dealing with the igneous Dharwars on the south in Mysore and the officers of the Geological Survey of India were dealing with the sedimentary facies of the Dharwars in the north, a place may be found where both the facies of Dharwars might occur. It has therefore become a very responsible work for the present and future geologists of Hyderabad to go into this question deeply and bring in facies to harmonise the controversy.

Champion Gneisses

We have recognised during our survey, a series of highly crushed micaceous gneisses, quartz schists, quartz porphyries and other ultra-acidic schistose rocks, now and often containing blebs of opalescent quartz, closely associated with the Dharwars, which appear to be lithologically similar to the Champion gneisses of Mysore. It is also significant that our field observations are in accordance with the views expressed by the late Prof. Iyengar[1] who relegated the horizon of the erruptive unconformity between these acidic schists and the later Peninsular gneissic complex and not between the acidic schists and the Dharwars as was originally proposed[2]. These rocks of the Champion series are so intimately associated with the Dharwars, sharing with them all the tectonic disturbances that it makes it practically impossible to

Eruptive unconformity.

1. "Acid Rocks of Mysore" P. Sampat Iyengar, Bulletin No. 9, Mysore Geological Survey.

2. Dr. Smeeth, Presidential Address, Ind. Sc. Con. 1924.

separate one from the other, but nevertheless they show specific intrusive relation to the schists.

Peninsular Gneissic Complex.

Conceding this eruptive unconformity as suggested above, the next set of formation in the archæan evolution in Hyderabad leads us to the most baffling series of rocks termed the Peninsular gneissic complex which forms the major portion of the Indian Peninsula.

The work done so far is neither intensive nor extensive, to arrive at a hypothesis for a genetic system of evolution of this great complex.

In his Presidential address in 1924, Dr. Smeeth[1] divided the Peninsular complex broadly into the following three main groups :—

1. Closepet granite complex and other granites.
2. Charnockites.
3. Peninsular gneisses.

Our study of the Peninsular complex in parts of Hyderabad State has revealed similar complexity of the whole gneissic formation which has so far baffled our detailed classification into specific types. Our survey has, however, enabled us to regard the archæan gneisses under two main divisions, namely, (1) an older grey and pink division, and (2) an younger porphyritic granite and red syenite division. Charnockites have been recently recognised in parts of Warangal district.

Grey and pink series of gneisses.

The Peninsular gneisses seem to lend an opportunity for a rough classification from the colour of the felspars contained in them. They are therefore divided into two main divisions, namely, an older grey series

1. Ind. Sc. Congress, 1924.

and an younger pink series characterised by the presence of grey or white and pink felspars. Though one phase gradually shades into the other yet, broadly speaking the pink series are found to show an intrusive relation with the grey series, each series being characterised by its own set of pegmatites and quartz veins. It is significant that the maximum development of the pegmatites is observed along the contact zone of the Dharwars with the Peninsular complex.

The porphyritic granites and red syenites occur as intrusive laccolithic masses and dyke-like injections in the grey or the pink series or in both. These appear to be the youngest granitic gneisses of the complex and are therefore comparable with the younger closepet granites and granitic complexes of Mysore.

For a more detailed discussion as to the origin and the inter-relation between the Dharwars and the gneisses, the origin and evolution of the Ferruginous quartzites and the mode of differentiation and regional features of the Peninsular complex as studied so far in the State, reference to our departmental publications may be made.

Epidiorites.

While mentioning the absence of type charnockites in our area, I should like to make a reference to a particular metamorphic facies of the Dharwars represented by the epidiorites which occasionally occur fringing the main Dharwar basic formations or as isolated bands within Dharwar belt and in its continuity. They occur as a metamorphic facies of the Dharwars, assimilating materials both from the basic schists and the acidic gneisses. They essentially consist of hornblende, mostly shredded, plagioclastic felspars with some orthoclastic varieties highly sericitised with kaolinised decomposition products with the development of

sphene and apatite ; quartz also occurs. Types have been recognised from the acidic to the basic varieties depending upon the relative proportion of the assimilated material and the degree of metamorphism to which they were subjected. Garnets are very rarely developed. In the scale of metamorphic classification enunciated by Grubermann this epidioritic phase appears to answer to the middle or the meso-stage. It is interesting to note that Vredenburg[1] suggested that the charnockites are an acute phase of metamorphism of the Dharwars. It would therefore be pertinent to enquire if these epidioritic forms may be considered as only a stage in the ultimate metamorphism of the Dharwars into charnockites. For a discussion on this subject reference may be made to Journal, Hyderabad Geological Survey, Vol. III, pt. i.

A little diversion here may not be out of place.

Dr. Fermor in his publication[2] on the correlation of the ancient schistose formations of Peninsular India has divided the country into two main regions, viz., the non-charnockitic and the charnockitic. Except for a little portion in the east in the Warangal district the whole of the complex of Hyderabad State comes under the non-charnockitic region. But only a detailed survey by the department can show the alignment of the dividing line accurately, as it appears that rocks similar to charnockites occur also in portions of Karimnagar district. Whatever that may be, broadly speaking, a major portion of the State may be considered, so far as our present knowledge goes, to be non-charnockitic.

Porphyritic granite.

Next we pass on to the youngest members of the crystalline complex which are represented by a series of later porphyritic

1. Presidential address, Ind. Sc. Congress, 1919.
2. L. L. Fermor, Mem. G. S. I., Vol. LXX, Part 1, 1936.

granites and coarse red syenitic rocks and other binaries of the acidic intrusives comparable to the closepet granite complex series of Mysore.

It has been found that porphyritic granites and red syenitic rocks have had their maximum development both in the Kistna and the Tungabhadra basins fringing a central mass composed of older Peninsular gneisses. Such a distribution should naturally indicate some zones of weakness through which these rocks could have found outlet.

The suggestion given by Dr. Fermor in his recent publication referred to above, that the relative elevation of the charnockitic region may be due to a relative vertical uplift along the belt of weakness—a fault zone along the junction between the charnockitic and non-charnockitic regions, is supported by the seismic data which show that the charnockitic terrain is less stable than the non-charnockitic region.

It is therefore suggestive that such seismic regional disturbances must have had their counterparts in the non-charnockitic region in inducing prominent zones of weakness and fault lines through which later granitic intrusives could have found their way.

The courses of the prominent rivers like the Kistna and Tungabhadra seem to have been determined by the zones of weakness through which they must have carved their course aided by differential denudation. This is exactly what we find in the regions fringing the Raichur Doab. If such tectonic disturbances were of a widespread character resulting in the formation of zones of weakness in the continental floor, the occurrence of these younger series of granites and their widespread distribution can perhaps be easily accounted for. This relation, therefore, may be considered contemporaneous or

rather later to the seismic disturbances connected with the charnockitic evolution.

We thus see that the evolution of the porphyritic granites and their associates are decidedly subsequent or younger to the charnockitic series and compares in harmony with a similar evolution established by the Mysore Geologists as represented by the closepet granites.

Salinity.

Both in India and South Africa, it is a common experience of the Geologists to find salt and saline springs associated with pegmatites at the junction zone between the Dharwars and the gneisses. Examples of such phenomenon in Raichur Doab and Surapur taluq are common where saline efflorescence and weak brine occur extensively in localised centres and indigenous salt industry has been carried on from time immemorial. Bruce Foote[1] considers that such saliferous activity is of deep-seated origin. Our examination of the area fully confirms this view and reveals that the saliferous activity so closely associated with the pegmatitic zones, especially in the later pink members is due to progressive fractionation of the acidic members of the Peninsular gneissic complex with which the ingredients were genetically associated in their deep-seated condition. Their association particularly with the auriferous areas of the Dharwars is more than an accident. This specific distribution of salinity is very clearly brought out in the Doab. The contact zone of the auriferous Muski-Wandalli band of Dharwars is highly saliferous but in the Kushtagi-Hungund Band which is non-auriferous, salinity is poorly developed. Similar relation is borne out in the Surapur area to the north of the Kistna where the Mangalur Band of Dharwars constitutes the northern extension of the auriferous

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1. Mem. G. S. I., Vol. XII.

Muski Dharwars of the Raichur Doab. The present distribution is however controlled not only by the pegmatitic centres but also by the meteoric circulation shifting from place to place in their neighbourhood in isolated hydrographic basins. The question of salinity has been studied in detail in the Raichur Doab and parts of Gulbarga district, and the results of this enquiry are published in the Departmental Journals.

Whether the conditions so far observed are of any uniform or widespread character remains to be seen when the other parts of the State where Dharwars are reported to occur but still unmapped, are taken up.

Eparchæan Interval.

The close of the igneous activity marked by the evolution of the porphyritic granites red syenites and associated pegmatites brings us to a period of quiescence ushered in by the beginning of the great Eparchæan interval. This interval so far studied in Hyderabad separates the Archæans from the Puranas. This interval of time is unrivalled in the geological history of India and must have witnessed the culmination of the folding and crumpling of the archæan rocks into high ridges only to be worn down through countless ages to their base level of erosion before they finally got submerged below the waters of the Purana seas. During this period, huge tectonic disturbances leading to the transgression of the Purana sea resulted in an isostatic regional variation of the ocean level. A quieter period representing denudation and deposition must have marked the closing of this great Eparchæan interval.

Other than the above considerations supported by the enormous denudation of the archæan rocks which must have been of enormous magnitude in this country, we have very little positive evidence from

the field to mark this huge interval of time except perhaps to attribute some of the fragmentation of the pegmatitic and quartz spreads below the Dharwars to some stages in the huge break.

DYKES.

The dyke rocks of Hyderabad may conveniently be divided into two main heads :—

(1) The contemporaneous trap dykes and hornblende dykes of Dharwar age.

(2) The Cuddapah lava flows and sills ; dykes of Dolerite character.

The former group is distinguished by the complete amphibolisation of the pyroxenes, while the latter is characterised by little or no amphibolisation of the augites. The Dharwar dykes are recognisable as hornblende dykes, amphibole dykes, amphibole peridotites, green stones and epidiorites. The association of steatite or talc with altered amphibolite and also of tremolitic asbestose is an occasional feature with some of these Dharwar dykes.

The second group of dykes which appears to be of lower Cuddapah age is mostly doleritic in character passing at times to epidiorites due to partial alteration of the augites into hornblende. That these dykes belong to the latter group can be definitely established as they are always found intrusive into the gneissic complex and also to some of the members of the Cuddapahs.

One peculiar structural feature in the distribution of dykes may here be mentioned. At or near the Dharwar margin especially along the concavity of the gneissic bays these later doleritic dykes seem to have developed in parallel runs along lines of weaknesses

produced by the impact of the gneissic invasion against the bands of pre-existing Dharwars. The strike of these dykes generally follow the main structural foliations of the gneisses and sometimes at right angles to them, along their main fissures.

Purana Group.

We may now pass on to the next group of rocks, namely, the Puranas (Pre-Cambrian). Dr. Fermor in his publication referred to above, uses the term archæan, as applicable to all formations below the eparchæan unconformity, separating the Cuddapahs and the other unfossiliferous formations lying above the unconformity, termed Purana by Dr. Holland.

The Purana group of rocks are scattered in isolated basins within the State and a glance at the map will show their distribution. These formations are unfossiliferous, though very puzzling concretionary and weathered fragments in the beds often simulate some fossil forms. These beds usually occur with low angles of dip over considerable areas and only appear highly tilted along a few zones of special disturbance. These formations being unfossiliferous, correlation is based mainly on lithological grounds and each separate group has been named after the type-area in which it has been noticed. The Cuddapah formations occur along the north bank of the Kistna river in Achampet taluk south of Nalgonda, underlying the Kurnool beds and along the Kistna river after its confluence with the Tungabhadra. They mostly consist of slates, quartzites and limestones. In addition to the above beds classed under Cuddapah, we have within the State some groups of sedimentary rocks known as Pakhals, Pengangas, Sullavai beds and Bhimas.

These have been studied in their type-areas from which they derive their name and are regarded as of Cuddapah and lower Vindhyan age, respectively.

The next higher series of beds are represented by the Kurnool series of rocks which are however not much developed within the State. Near Alampur and along the left bank of the Kistna river both diamondiferous quartzites and conglomerates occur and have remained unworked. These areas have not yet been studied in detail by the Department and it is proposed to take them up in the near future. Closely related to the Kurnools and resembling them in lithological characters are the Bhima series of rocks so called from the river in whose basin these formations occur. On their north western border these beds are covered by the Deccan Trap flows and on the north east border for a long distance they rest on the archæan gneisses. The Upper Bhima is chiefly a limestone formation, though beds of shales occur occasionally and sandstones and shales constitute lower members of the series. The limestones are fine-grained and possess a texture approaching lithographic stone. The grey colour prevails ; pink black, yellow and other tints are not uncommon. The rock occurs as flagstones and are largely used for building, especially for flooring. The limestones of this series yield good material for cement manufacture and is extensively used in the Shahabad Cement Works. The black varieties take nice polish and can be used for decorative purposes as a cheaper substitute for marble. The association of iron pyrites with these limestones, sometimes seggregated in layers, has been noted in Surapur, Andola and Gulbarga taluks.

We have now to pass over a big hiatus in the geological history of Hyderabad before we come to the Gondwana formations, the earliest fossiliferous strata inthe State. Rocks of Carboniferous to Cambrian age (Dravidian group) are unrepresented within the State limits.

Gondwana System.

The Gondwana formations are the next group of rocks met with in the State. Without digressing into the details of these formations, the reports of which are available in the Records[1] and Memoirs[2] of the Geological Survey of India, it may be pointed out that these formations occur in the eastern and N. E. border of the State fringing the Pranhita, Wardha and Godavary basins.

These areas have attracted the attention of geologists due to their economic possibilities and the Singareni Collieries have long been in existence tapping coal in these beds. The activities of the Collieries have now been transferred to Kothagudium, a newer area for the development of the coal resources of the State, the Singareni area having been recently abandoned.

Our departmental survey in portions of Asifabad district and the activities of other prospecting companies have brought into light the continuation of coal-bearing beds along the belt. About 25 sq. miles of coal-bearing Barkar rocks have been proved to exist to the south of the Godavary in the Jangaon area, Sultanabad taluk, Karimnagar district of which 800 acres have been fully proved by bore-holes where good second class coal is available at economic depth to an estimated quantity of about 38 million tons.* The activity of the coal Companies are being sufficiently encouraged for a wider scope of operation.

In addition to the coal mining at Singareni, other operations are also being conducted both at Tandur and at Sasti areas in the N. Godavary Valley.

The fossils found in the Gondwana rocks and specially the saurian reptilian remains from the

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1. G. S. I. Rec., Vol. XI.
2. ,, Mem. Vol. XVIII and Mem. Vol. XIII.

* Unpublished report by Mr. A. B. Hughes.

Kota-Malari group in Asifabad district have received world-wide attention.

Workable iron-ore is found concentrated in the upper beds of the Gondwana series and extensive deposits are noted in portions of Asifabad and in Warangal districts. Fire-clay and pyritiferous nodules have been noted in association with the coal seams.

Deccan Traps.

Next in order of succession we have the Deccan Trap rocks occupying nearly one half of the State. The Hyderabad Traps are regarded as belonging to the middle series with some Inter-trappeans. These formations are engaging the special attention of this Department from their water-bearing point of view. As it is well known that the flows consist of hard basaltic trap, intercalated with softer vesicular layers which are susceptible to greater decomposition and consequent storage of water, it has been found by careful study of natural sections and well-logs that there are specific layers in certain horizons which are aquiferous and wells driven to these depths have proved of successful perennial supply. By a careful study of these physical features it has been made possible to reduce the element of chance to its minimum and save lot of money for the public which would have been otherwise wasted. Though it has been found that any correlation in a particular area may not be so uniform or widespread as to make it of universal application, yet the knowledge gained in this study has proved of immense value within the area limited by such co-ordination.

The Deccan Traps are sometimes capped by laterites. The laterites vary from highly ferruginous to practically alluminous boles and have yielded iron-ore for local smelting. These high-level laterites form the great Bidar plateau and are found scattered

at Vikarabad, Ananthagiri, parts of Nizamabad district and elsewhere. At places where it is very thick it offers at its base basins for storage of water and wells in such areas yield drinkable water with characteristic iron-taste and tonic properties. Vikarabad is growing into a sanitorium not only due to its comparative height but also to the presence of such mineral water.

Intertrappeans.

Intertrappeans are rarely met in the Deccan Traps of the State. A few fossiliferous areas, however, consisting of lamelli branches and gastropods have been noted in parts of Nizamabad, Parbhani and Gulbarga in course of the survey.

Lametas.

Some stray patches of lameta beds or infratrappeans have also been recently located in Surapur taluq with interesting vertibrate remains. These areas are engaging our attention.

Pliestocene and Recent.

A few remarks here may be added regarding the recent formations of the alluvials, and the soil groups of the State and artifacts of apparently human manufacture reported from some of these recent formations. These afford good examples of the trace of man in the Pliestocene gravel beds. Silicified wood and mamalian bones are also met with in the Godavary alluvials. The Kistna gravels are similar to those of Godavary and the deposits of importance in this connection are the diamondiferous gravels which consist of sandy shingle composed chiefly of quartzites. The gravels occur at considerable elevations above the river and are covered by the black-cotton soil. The diamond mining in the State is now at a stand still, yet there remains, specially around Partial and Nandikonda, large areas whose diamondiferous gravels must be lying untouched.

SOIL.

The soils of the State may be broadly classified under two main divisions.

1. Black cotton soil generally covering the Deccan Trap and the Dharwar schist areas and shifting much beyond their boundaries by the normal methods of migration.

2. Loamy gneissic soil occupying a great portion of the archæan country with its sub-soil or moorum. Lignitic and peaty soil even now occur in swampy areas in the neighbourhood of Barakar series of the Gondwana formations in Chinnur taluq, Asifabad district.

The question of soil erosion and shifting has become a serious problem for the agricultural geologists and some portions of the State are heavily exposed to impending dangers of complete soil erosion and eventual barrenness if no precautions are immediately taken. Semi-arid areas like Raichur and portions of Deccan Trap districts are constantly exposed to this menace of shifting soil and the local methods of field-bunding is rather a poor check against the rapid and extensive soil erosion. A comprehensive scheme of reforestation and organised methods of field-bunding appear to be the effective measures for the prevention of this erosion which is already engaging the attention of the Government.

SECTION III.

Economics.—As the literature on the mineral resources of the State is scattered in several publications and in unpublished departmental reports and many occurrences have not been given publicity, the available information is outlined below. Minerals which have been noted so far by departmental surveys or by previous observers are detailed hereunder.

I. Precious metals and minerals.

1. Diamond.
2. Gold.
*3. Silver.

II. Base metal minerals.

1. Iron.
2. Lead (Galena).
*3. Manganese.
*4. Copper.
*5. Antimony (Stibnite).
6. Sulphur (Pyrites).
*7. Arsenic (Lollingite).
*8. Ilmenite.
*9. Chromite.

III. Non-metallic minerals.

1. Coal.
2. Mica.
3. Graphite.
4. Talc and soapstone.
*5. Flourite.
6. Calcite.
*7. Serpentine.
8. Zeolites.
*9. Barytes.
10. Semi-precious stone.

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*Occurrences reported but not of commercial importance.

(Amethyst, chalcidony, onyx, agate, jaspar, plasma, bloodstone, opal, garnets, kyanite, *etc*).

IV. Materials for industrial application.

(*a*) Paints and distempers.

1. Ochre.
2. Laterite and aluminous boles.

(*b*) Ceramics.

1. Kaolin.
2. Felspars.

(*c*) Glass.

Quartz.

(*d*) Cement.

V. Salt deposits.

(*a*) Common and tanning salts.
(*b*) Saltpetre.
(*c*) " Dhobies' earth, " etc.

VI. Clays.

(*a*) Kaolin.
(*b*) Fire clay, etc.
(*c*) Fuller's earth.
(*d*) Brick earth and potter's clay.
(*e*) Other clays.

VII. Abrasives and refractories.

1. Garnet.
*2. Corundum.
*3. Kyanite.
*4. Staurolite and andalusite.

VIII. Building stones.

1. Dharwar building stones.
2. Peninsular granites.
3. Limestones.

4. Marble.
5. Sandstone.
6. Slate.
7. Trap rocks and laterite.
8. Lime kanker.

IX. Springs and mineral waters.

X. Water falls.

I. Precious Metals and Minerals.

1. *Diamond.*

Tavernier in his ' Travels ' describes in detail the working of diamond mines in the Deccan. His route passed right across the State from Daulatabad, via Golconda and Hyderabad, to Masulipatam. Golconda was, from early Hindu times and subsequently under the Kutbshahi dynasty, the world's mart for diamonds, but diamonds were never found there. They were mined far to the south along the banks of the Kistna river; but it was only natural that the name of Golconda, the Capital, which was only a treasury and the place where they were cut and sold, should be connected with the industry. The area on which the Golconda Fort stands is wholly on Archæan granites.

The famous Partial group of diamond mines lies on the north bank of the Kistna within the State. Some of the best Indian diamonds have come from the Kistna basin, a good part of it lying within the limits of the State. The Partial group of diamond mines were recently inspected and the desirability of a detailed investigation has been suggested. Boring need not be employed. Sinking of pits in favourable localities, washing and sorting the gravels over grease plates should settle the value of these alluvials more definitely than the costly experiments of the Hyderabad (Deccan) Company.

The Hyderabad (Deccan) Co. Ltd., who held the mineral rights of the State, opened the old workings for diamonds at Partial and extracted 3,444 stones weighing 2,085 carats. Most of these diamonds were of poor quality. The company subsequently abandoned the working in 1894 as being unprofitable. The Geological Survey Department has recently taken up the general survey of the sedimentaries of the north Kistna basin.

The following are some of the famous diamonds found in the Kistna basin* :—

(1) *Koh-i-nur.*—This was found at Kollur, in Madras, south of the Kistna, about 1656-1657 and was presented by Mir Jumla to Shah Jehan. The stone weighed 787½ carats. It passed through many hands and is in the Imperial Regalia.

(2) *Pitt or Regent.*—This was found in 1701 at Partial, weighed 410 carats, and is now the property of the French Republic. It is exhibited in the Apollo Gallery at the Louvre. It is valued at £ 48,000. It was reduced by cutting to about 137 carats.

(3) *The Hope diamond.*—Perhaps this is a portion of the blue drop-form diamond found at Kollur and sold by Tavernier to Louis XIV in 1642. It then weighed about 67 carats.

(4) *The Nizam diamond.*—The Nizam, 277 carats, is only a portion of a stone which is said to have weighed 440 carats before it was broken. (Ency. Brit.).

2. *Gold.*

Numerous old workings for gold scattered in various parts of the Raichur Doab and Surapur taluk of

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*For a fuller description of these diamonds see J.H.G.S. Vol. I. Pt. i. pp. 21-62.

Gulbarga district, afford ample evidence that at some unknown date this country was systematically explored, prospected, and mined for gold by a race of people highly skilled in mining and simple practical methods of metallurgy. The main Hutti old workings which reached a phenomenal depth of 640 feet—unknown in any other part of the world in ancient metal mining—testify to the skill of these ancient miners.

The modern history of the discovery of gold in Hyderabad State dates back to 1886, when the Hyderabad (Deccan) Co., which was formed to explore and exploit the mineral resources of H.E.H. the Nizam's State and conducted intensive prospecting for gold. Their prospecting operations extending over a period of twelve years (1887-1899) resulted in the discovery of more than three hundred old workings scattered over parts of Hutti, Wandalli, Maski, Topaldoddi and Budhini in the Raichur Doab, and the Mangalur field in the Surapur taluk of Gulbarga district. Most of these old workings received attention but only a few of them could be unbottomed. Now, realising that all these operations made a heavy drain upon their resources, the Hyderabad (Deccan) Co., formed subsidiary companies to work different areas of the auriferous tract.

Thus :—

(1) The Wandalli (Deccan) Gold Mining Ltd., began operations at Wandalli Mines in 1895. Expert opinion has it " That the Wandalli Mine seems to have had great possibilities that were never realised..... that work there should not have been abandoned without further exploration in depth. "[1]

(2) The Hutti (Nizam's) Gold Mines Ltd., was floated in 1901 to work the Hutti mines and

1. J.H.G.S., Vol. II, Part 1, p. 84 (1934).

had a successful career for about 16 years during which time gold to the value of £ 900,000 was recovered and about £45,000 in royalty was paid to Hyderabad State, before they were finally closed down in 1920 after the Great War.

(3) The Topaldoddi Gold Mines Ltd., conducted operations in the vicinity of Topaldoddi and Chincherki.

Subsequently the Deccan Gold Fields Development Co. Ltd., was formed in 1905 to examine all the old workings left untouched by the previous prospecting operations. It concentrated on the Mangalur field, and left the Maski operations under an arrangement with Messrs. John Taylor & Sons. But all work had to be closed down owing to the outbreak of the Great War in 1914.

The Hyderabad Geological Department took up the revision survey of the gold-bearing rocks of the Raichur Doab, and continued its work northwards to include the Mangalur field in Gulbarga district. With the knowledge of the operations and the results of the previous prospecting companies, more intensive work was conducted by the Geological Survey not only in the areas where prospects were reported to be encouraging but also in the areas outside the con-- cessions of the Hyderabad (Deccan) Co. Thus South Maski Field, in Udbal zone, received attention. A new area near Hunkuni, in Deodrug taluq, was also prospected where a long line of old workings was partially opened out.

The favourable indications obtained during the departmental activities in the auriferous tracts have resulted in a scheme for the revival of gold mining in the State. Encouraged by the opinion of mining experts, the Hyderabad Government have now launched upon a programme of detailed prospecting

in the most favourable zones, viz., Mangalur, Hutti and Maski areas. This prospecting work is conducted by Messrs. John Taylor & Sons under the direction of H.E.H. the Nizam's Railway Board and financed by the State. A sum of 8 lacs has been budgetted for this purpose. Messrs. John Taylor & Sons started prospecting work in December 1937. Numerous old workings have been trenched in these areas either in continuation of or in proximity to those already prospected by previous companies. Some of these trenches have exposed quartz stringers and veins which carry traces of gold. Modern methods of geophysical prospecting has been adopted in localities suitable for this type of work. Diamond drilling operations are being conducted so as to prove the continuity of known auriferous quartz reefs in depth. The Village Reef Mine, near the old Hutti Mine, has been unwatered and developed, with detailed sampling. The results of prospecting work by Messrs. John Taylor & Sons have been very satisfactory and Government is contemplating the continuation of the development work.

Output and royalty on gold produced in Hutti, Topaldoddi and Wandalli Mines are given below.

[*Statement.*

Output and Royalty on Gold produced at Hutti Mines from 1903 *to* 1920.

Year	Output in ounces	Royalty B.G. Rs. a. p.	Remarks
1903 ..	..	10,668 0 0	
1904 ..	8,349	30,134 8 7	
1905 ..	13,167	37,242 13 3	
1906 ..	13,500	39,814 13 3	
1907 ..	14,897	37,117 14 6	
1908 ..	14,700	40,044 2 1	
1909 ..	16,202	42,512 2 3	
1910 ..	17,248	43,958 13 6	
1911 ..	15,135	13,924 13 1	Royalty at 2½ per cent.
1912 ..	14,019	48,109 11 10	Royalty at 5 per cent.
1913 ..	20,012	57,372 5 5	do
1914 ..	20,616	59,777 12 4	do
1915 ..	17,870	48,650 12 2	do
1916 ..	17,911	53,795 14 1	do
1917 ..	13,774	18,936 15 6	Royalty at 2½ per cent.
1918 ..	11,364	14,270 10 7	do
1919 ..	10,591	11,684 10 9	do
1920 ..	12,391	14,577 7 9	do

Output and Royalty on Gold produced at Topaldodi and Wandalli 1908 *and* 1909.

Year	Output in ounces	Royalty B.G. Rs. a. p.	Re-marks
1908—April to December	3,721.700	6,234 2 7	
1909—Jan. & Feb. ..	324.400	534 15 0	

3. *Silver.*

No ores of silver have been reported. In addition to the small percentage of silver associated with gold, a minute quantity of silver has been found associated with galena in Nalgonda district, ranging from 1.1 to 1.7 oz. troy per ton of lead.

II. Base Metallic Minerals.

1. *Iron.*

Iron-ores in the form of magnetite, hæmatite and limonite are extensively found in various parts of the Dominions in almost all the geological formations from the Dharwars to the Deccan Trap laterites.*

Iron smelting has been known in the State from the late neolithic age, as evidenced by the association of neolithic implements with iron-slag.

Voysey records in 1833 A.D. that Konasamudram was visited by Persian traders for steel out of which the world famous Damascus swords were manufactured. This steel, famed as Indian 'wootz,' was well known throughout the mediæval world. In ancient times the people of India seem to have acquired a fame for metallurgical skill and the reputation of the wootz steel, which was certainly made in India long before the Christian era, has probably contributed to the general impression that the country is rich in iron-ore of a high class. It is now seen that its qualities were not derived from any special virtue of the ore, but in the fuel, charcoal and in the treatment of the iron by hammering, reheating and carburisation in the charcoal. The light ferruginous brown laterite ore from Tadpolli (Nizamabad dis-

*For a detailed description of the iron-ore deposits of the State see Bulletin No. 4., Hyderabad Geological Survey.

trict) was largely used in the manufacture of the Konasamudram steel.

Deposits of iron-ore have been noted in Nirmal, Yelgadap, Utnoor, Lakshetipet, Chinnur and Sirpur taluqs of Asifabad district; Armur, Kamareddi, Yellareddi and Gandhari Jagir of Nizamabad district, in the Kushtagi ferruginous quartzites of Raichur district, and in Parkal, Jugtial and Sricilla taluqs of the Karimnagar district.*

A long run of low ridges consisting of iron-ore bands occurs south of the Singareni Collieries. The importance given to these deposits by Bruce Foote appears to be unwarranted as disclosed by recent surveys.

In 1349 F. an investigation of the known occurrences of the iron-ores, particularly in the Asifabad, Nizamabad and adjoining areas, was undertaken to gauge the potentialities of the available raw materials to start an iron industry in the State.

Prospecting licences and mining leases over the Chityal, Dasturabad and Chichiala area in the Adilabad district were formerly granted to Sir Fazulbhoy Currimbhoy of Bombay who has since surrendered the lease. The Hyderabad Construction Company has been granted a prospecting licence for iron in Chandoli area (Amberpet), Jagtial taluq, Karimnagar district.

Distribution.

The following are some iron-ore areas dealt with under various geological formations.

I. Iron-ores of the Dharwar Series.†

The iron-ores of the Dharwar series consist of a

**Ibid.*, Bulletin No. 4.

†Abridged from report by Dr. A.M. Heron, Special Officer, Geological Survey and Mineral Works, Hyderabad.

succession of intensely crumpled layers of alternating hæmatite or magnetite and quartz, the iron oxide and quartz usually in approximately equal amounts, the layers being generally $\frac{1}{8}''$ to $\frac{1}{4}''$ thick, $\frac{1}{2}''$ thickness being about the maximum. The folding is close and complicated on a small scale but conforms when looked at broadly to the general strike of the whole band. The ironstone bands may range from a few inches to several feet in thickness and from a few yards to 3 or 4 miles in length. The usual average thickness of the bands is about 50 ft. and the maximum about 160 ft., as in the Chityal hills. The general dip varies in different occurrences and at different points in the same band, verticality being the commonest attitude. In the Amberpet group of hills the dip of the bands is exceptionally low, 22° upwards.

Massive unlaminated magnetite without quartz is rare. Sometimes the magnetite layers, when they are exceptionally thick, up to an inch, are coarsely granular and chrystalline, but in the whole of the Godavary river section at Chityal, totalling 150-160 ft. thickness of ironstones, only one layer was seen up to 6 inches thick and traceable along the strike for several yards. On Chandoli hill (Amberpet) there is a bed of rich ore, running 65 per cent. iron, 3 to 6 ft. in thickness, containing about 5,000 tons of ore, with other layers adjoining it.

These quartz-hæmatite and quartz-magnetite ironstones are very common but most of these occurrences consist of quartz and iron so intimately blended that only a highly siliceous ore of a low grade can be obtained without artificial concentration. These occurrences are so common in India that newly recorded instances are generally passed over as matters of very little immediate economic interest.

I. Major Occurrences of Iron-ore.

There are six principal occurrences of these banded ironstones in the Dominions in the Dharwar rocks, *viz.*, (1) Chityal, (2) Kalleda-Dasturabad, (3) Rebanpalli in the Adilabad district, (4) Chandoli (Amberpet) in the Karimnagar district, (5) Singareni in the Warangal district, and (6) Tawargeri in the Raichur district.

1. *Chityal.*

The western band of the ironstones of the Chityal hills in Yelgadap taluq is estimated to contain about 20,000 tons, the eastern band about 2,000,000 tons and the northern hill (1,113) about 1,000,000 tons of ore. In the hill 1255 ft. the iron band is estimated to contain about 250,000 tons in the thinner portion south of the saddle, and in the thicker northern portion about 3,700,000 tons of ore.

2. *Kalleda-Dasturabad Group.*

This group of iron-ore hills is situated in Lakshetipet taluq. The hill 1,444 is estimated to contain 4,000,000 tons of iron-ore. The band to the west of 1,444′ contains about 375,000 tons of iron-ore and the ridge 1,387′-1,142′ about 1,000,000 tons or iron-ore.

3. *Rebanpalli Area.*

In the Rebanpalli area in Lakshetipet taluq the quantity of ore available from the main ridge is about 3 million tons, and from 866′ hill about 2 million tons.

4. *Chandoli (Amberpet).*

The magnetite or hæmatite and quartz rocks of this area in Jugtial taluq are similar to those of Adilabad, the iron contents ranging from 35 to 40 per cent. iron with a band of richer stuff, in places

nearly pure magnetite. The total quantity in this area is estimated to be about 12 million tons of ore. Surface ores and outcrops on Chandoli hill alone should yield 2,800,000 long tons of clean (40 per cent.) ore. After allowing for unavoidable working loss of iron in concentration and smelting, this should produce 750,000 tons of iron metal.

There are other and similar ores in the immediate nieghbourhood notably at Kondapur. An aggregate of at least 2,000,000 tons of iron is obtainable from this area.

5. *Singareni Area.*

The iron-ores of this area occur south of the Singareni Collieries in Yellandu taluq. This ore-body is similar to those of Adilabad and Karimnagar. It consists of extremely hard magnetite quartz schists of which by volume less than half is iron. The iron-content is too low, and the estimated quantity of ore is about $5\frac{1}{2}$ million tons down to the plain level.

6. *Tawargeri Area.*

The most important occurrence of iron-ore in Raichur district is near Tawargeri, in Kushtagi taluq. The iron-ore is found distributed in alternating layers with quartz, and in favourable places the iron is concentrated, as at Jajadgudda, where old workings for iron are noted. Average samples collected from the area have assayed between 35.7 to 48.1 per cent. of iron.

MINOR OCCURRENCES OF IRON-ORE.

II. Iron-ores from the Peninsular Gneissic Complex.

Iron-ores are sometimes found associated with the rocks of the Peninsular complex but economically these are not of importance.

III. Iron-ores of the Purana Sedimentaries.

Iron occurs as sulphides in the form of iron-pyrite in the limestone beds of the Bhima series in Surapur taluq but the occurrences are not extensive.

King refers to the extensive association of iron-ore in the Purana sedimentaries of the Kistna basin. Recent surveys in the area have not, however, disclosed any workable deposits of iron-ore. The Jatpole area which was reported to contain high-grade ore was investigated in detail and was found that the amount was trifling.

In the Bhima formations highly ferruginous hæmatitic shales 2 to 3 feet thick have been noted in between shales, near Bankur in Gulbarga taluq. These ferruginous shales assay 63 per cent. Fe. but are not of sufficient magnitude to be of economic importance as an iron-ore.

IV. Iron-ores from the Gondwana Formations.

Hæmatitic nodules occur in the Chikiala beds (upper-most Gondwanas) in the Sirpur taluq of Adilabad district and were used by the old iron-smelters. Such occurrences are near Chikiala, Agarguram, Loha, Pangarigutta, Jhandagutta and Pochammagutta, but are not a source of iron-ore commercially.

V. Iron-ore in Laterites.

The next formation which was a source of iron is the Deccan Trap laterites. Areas of ferruginous varieties of laterite occur in many parts of the Deccan Trap formation.

The following localities may be mentioned. There are extensive lateritic caps at Bidar and Kalyani, Vikarabad and in parts of Nizamabad and Adilabad

districts. The Bidar lateritic cap is about 28 miles long and 22 miles broad and that of Kalyani is more extensive. Smelting is said to have been carried on in several localities in the lateritic areas, as evidenced by extensive slag heaps. Some of the lateritic ores assayed up to 60 per cent. Fe_2O_3.

Position of an Iron Industry in Hyderabad.

Hyderabad has no coking coal and the forests are inadequate to provide charcoal. The iron-ore is poor in quality (average about 40 per cent. Fe.), difficult to extract, refractory to the furnace and does not occur in large quantity in any one place. A large-standard blast furnace smelter is out of the question. In addition, there is little demand for the by-products.

A small plant modified to use ore and coal instead of coke, turning out a sufficient quantity of iron to supply the Dominions, is subject to the uncertainty of behaviour of the ore and fuel, hitherto untried, to the difficulties of mining hard ore-bodies and high overhead charges including the construction of many miles of railway.

Magnetic concentration as attempted by the Mysore Iron and Steel Works and by the Travancore Mineral Works, on iron-ores similar to Hyderabad ores have not proved successful.

The Hyderabad ore position is highly unfavourable in comparison with that of the iron industry established in India, in Bihar, Bengal and Mysore.

The iron-ores used by the three producing companies in India are quite different, being high-grade hæmatite. At Tata's Noamundi Mine the average day's run of ore is 62 per cent. Fe. and they can arrange consignments to Works of anything up to 69

per cent. Fe. The Mysore Iron and Steel Works use 55 per cent. to 64 per cent. ore.

In view of the absence of suitable coking coal for smelting, the possibilities of hydro-electric smelting of iron-ores are engaging the attention of the Government.

Taking a general view of the future of an iron industry in Hyderabad, Mr. G. Musgrave opines that conditions do change and it is possible to envisage a shortage of steel as a result of the enormous destruction of this war. Apart from Chandoli, it would be worth-while to explore the possiblilities of steel-production by electric smelting of scrap and purchased pig. A small industry might thus quite possibly be built up for making reinforcing rods, round and flat bars, light sections, etc., at a cost comparable with the cost of import. That industry would have the advantage of providing a means of educating some of the State nationale in the art of steel production. From that to the production of iron is a natural step. If political and other considerations ever arise, making it desirable for the State to produce its own iron, Hyderabad State is very likely to be in a much better position. From the point of view of the State Mr.Musgrave thinks that the cost of these investigations might quite properly be regarded as a long-term investment.

2. *Lead* (Galena).

Galena has been noted in a few localities in the State in small isolated veins in the granite rocks.

Near Maski, Lingsugur taluq, some minor streaks of galena are seen in the hornblende-schist dump near the old gold-working. At Hunkuni, Deodrug taluq, galena was identified in the siliceous hornblende-schist as disseminated grains in the mineralised zone.

A specimen of galena was sent to this Department from the pegmatities near Nawab Fakr-ul-Mulk's Mansion and further beyond in the Banjara Hills.

Galena was picked up in a field near Konneregudem, Devarkonda taluq, Nalgonda district, in 1929. In 1338 F. Mr. Narayandas Girdhardas of Madras obtained a *parwana* and prospecting licence for the mineral in Akkampalli area. But the enterprise was abandoned in 1339 F. as no favourable indications were obtained. Following up this information a search was made for galena in the Nalgonda district when the departmental survey was taken up in 1347 F. As a result of this enquiry galena-bearing veins were located within the village lands of Chintakunta, Pedda Adisarlapalli and Mallapalli. A line of old workings for galena, spread over a mile was also discovered about a mile and a half N.E. of Chintakunta. In fields on the Pedda Adisarlapalli-Chintakunta track, some scattered float ores subsequently led to the location of calcite veins containing galena traversing pink granites and epidioritic rocks. A more promising area was also noted about a mile to the north of this site. At Mallapalli four pits were sunk up to 35′ 6″, 22′ 15″ and 9′ in depth. At Pedda Adisarlapalli a fresh galena-bearing calcite vein 2′ wide was also encountered and at a depth of 12′, a mass of galena about $1\frac{1}{2}$″ in thickness. The associated minerals of the galena in the veins are quartz, calcite, pyrite, chalcopyrite, bornite, malachite, azurite and rarely fluorite. In the Nandikonda hill, in Miryalguda taluq, galena was found in a quartz vein.

The lead content of the galena ranges from about 80 per cent. to 84.9 per cent. and the proportion of the galena to gangue minerals varies from 24.01 per cent. to 1.5 per cent. The washed galena sand on treatment gave about 55 per cent. of lead. There is a minute percentage of silver associated with the galena. (*Vide* para on silver, page 38).

A scheme of prospecting work was sanctioned by Government and carried out by the Geological Survey to ascertain the potentiality of the fields. But from the work that was done it became clear that the galena occurs sporadically in the veins, in pockets and stringers, and the indications were insufficient to encourage economic exploitation. As the cost of blasting of the country-rock and dead-work entailed was heavy, further work appeared to be futile as an economic proposition and the operations were closed down. About 282 lbs. of crushed galena sand washed from the gangue of silica and calcite was recovered from some of the important excavations.

3. *Manganese.*

The importance of manganese in the manufacture of iron and steel is universally recognised, but only a few stray occurrences of manganese ore have been reported. The existence of manganese in the Bidar laterite near Halburga, about 16 miles north of Bidar, is reported by Newbold. The laterite is said to have been traversed by a network of veins about an inch thick consisting mostly of black manganese oxide with iron.

Manganese as an encrustation of pyrolusite, was noted near Rajampet and Kondapur in Kamareddi taluq, Nizamabad district. The mineral occurs in association with clacareous nodules about 18 inches thick, resting upon hard kunkar lime-stone and overlain by lithomarge and laterite soil. The occurrence does not warrant any economic exploitation.

The following are the analyses of the manganese ore from Kondapur and Rajampet.

Kondapur.		*Rajampet.*	
SiO_2	.. 33.1	SiO_2	.. 13.7
Al_2O_3	3.8	Al_2O_3	4.7
Fe_2O_3		Fe_2O_3	
Mn.	.. 19.8	Mn.	.. 49.8

4. *Copper.*

Old workings for copper have been noted at several localities in Raichur district, in Gadwal Samasthan, in Surapur taluq in Gulbarga district and Makhtal taluq in Mahbubnagar district. The segregations of sulphides are irregular in form and, in most places, the granites in contact with intrusive dioritic rocks are impregnated with the sulphides. Such impregnations are, however, local and unimportant and no workable concentration of sulphide ore in this form has yet been found. Some old workings with copper-stained debris are extensively met with in Gadwal Samasthan. Old workings were noted at Machnur and Chincholi in Raichur district and Tintini in Surapur taluq of Gulbarga district. At the junction of aplites and disbases, copper staining was noted south of Jagarkal, Mallapur and between Timapur and Gabur in Raichur taluq. Copper slags are found lying scattered in the vicinity. Along the eastern margin of the Mangalur patch of Dharwars in Surapur taluq, Gulbarga district, copper staining was also noted in the pegmatite veins. Quartz veins with copper staining were observed near Ramasamudram at the eastern margin of the Jaklair-Dharwar band and also on the Karne-Kalwal track in Makhtal taluq of Mahbubnagar district. A quartz reef, fringed by diabasic schist, outcrops between north of Siddapur and south of Benkanhalli in the porphyritic gneissic country in Surapur taluq. This quartz shows copper staining all along its run. Chalcopyrite and pyrites, malachite, cuprite and covellite are scattered in the quartz reef. Near the Parmanand hill, Surapur taluq in Gulbarga district, spreads of slag were noted. At Chintrala, in Nalgonda district, it is reported that malachite occurs between layers of slates. A number of old workings are found scattered over this area, apparently for copper. The Chintrala copper ore is a mixture of chalcocite and malachite, and assays 36.19 per cent. copper.

Old workings for copper have been brought to light during recent surveys about 2 miles north and north-east of Yellambailu in Palancha Samasthan.

An excavation for copper ore has also been noted about ½ a mile west of Kamsanpalli village, Achampet taluq, Mahbubnagar District, in a hill known as "Rajigutta".

Mr. Haji Sajan Lalji of Secunderabad and Messrs. Parry & Co. of Madras worked the Chintrala copper area at different times, but their efforts were apparently not successful. Subsequently, Messrs. Allauddin & Sons and Balaramaswamy, obtained a prospecting license in 1919, and renewed it for another year, but surrendered the license without doing further work in the area.

5. *Antimony* (Stibnite).

Stibnite is reported to have been found in a well at Yenchapalli in Karimnagar district at a depath of 34 feet.

6. *Sulphur* (Pyrites).

Pyrites occur associated with auriferous quartz reefs of the Dharwars and as disseminated grains in hornblende schists. They are met with in the lime-stones of the Bhima and Kistna basins as concretions.

A considerable quantity of pyrites is found associated with the coal seams of the Gondwana fields at Tandur, Kothagudium and Sasti collieries. It occurs in layers and lenses about ½″ to 1″ thick from top to bottom of the coal seams. It is thus not possible to mine it independently of the coal. The pyrites is handpicked from the coal in the screening plants and is collected in flat pieces with a certain amount of coal still sticking to them. The lumps would have to be pulvarised and the pyrites and coal separated. The presence of a little coal in the final concentration may, however, be an advantage in

assisting roasting. At Tandur it was found that 40 tons of pyrites per month is available from the Salar Jung seam alone. Thus if pyrites from all the working collieries are collected it would be possible to have a regular supply of the material to warrant the initiation of a sulphuric acid industry on a small scale. A small pilot plant has been erected in the Chemical Technology section of the Osmania University to utilise the pyrites for testing the commercial production of sulphuric acid.

7. *Arsenic* (Lollingite).

Sporadic occurrence of lollingite ($FeAs_2$) with arseno-pyrites in tourmaline-bearing pegmatite veins has been noted in a well at Mavinmatti at the margin of the Mangalore band of auriferous Dharwar schists in Surapur taluq of Gulbarga district. The mineral has not been found in any economic quantity.

8. *Ilmenite.*

Ilmenite commonly associated with basic rocks is often noted as sandy concentrates in streams and rivers. A scattered deposit of this ilmenitic sand has been noted along the Kistna river near Jaldrug fort.

9. *Chromite.*

Stray occurrences of chromite have been reported from the eastern part of Warangal district. Chromite is known to occur in the Kondapalle hills in the Kistna district of the Madras Presidency, touching the southern borders of the State. These hills continue into the Madira taluq, so there is a possibility of the occurrence of chromite. The survey of the area which is in progress may locate it.*

III. Non-metallic Minerals.

1. *Coal.*

The Gondwana coal-bearing rocks occur towards the east and north-east corner of the State, as a con-

*Note :—Chromite has recently been noted as float-ore on "Kattalgattu" hill near Bhimawaram and in the fields near the villages of Dendkuru and Nidanpuru in Madira taluq, Warangal District.

tinuous strip from the Wardha Valley, along the Godavary basin up to the State limits, occupying an area of about 3,800 sq. miles. The whole formation is not necessarily underlaid by coal seams. The actual outcrops of Barakars in which coal has been located are few and far between. The proved areas are enumerated as under :—

1. Sasti-Rajura Area.
2. Antergaon (Aksapur area).
3. Tandur area.
4. Chinnur-Sandrapalli area.
5. Karlapalli outlier.
6. Bandala outcrop.
7. Maddapuram-Allapalli area.
8. Opposite Lingala.
9. Yellandlapad (Singareni Coal-field).
10. Kothagudium.
11. Kannigiri.
12. Damarcherla.

The history of exploitation for coal in Hyderabad State dates from 1886 when the Hyderabad (Deccan) Co., started mining operations at Singareni by means of inclines and later, by vertical shafts.

The production was gradually increased to meet the growing demand for coal, and in 1921 the Singareni Collieries Co., Ltd., an Indian company registered in the Hyderabad State, purchased the Collieries from the Hyderabad (Deccan) Co., and developed the field.

The Singareni Collieries, the biggest coal-mining centre in the State, were situated in Yellandu taluq of Warangal district, about 144 miles from Hyderabad. The coal-field is connected by a 16 mile mineral line to Dornakal on H.E.H. the Nizam's State Railway.

This coal-field was discovered by Dr. King of Geological Survey of India in 1871, and the chief coal seam bears his name. The coal-bearing area is roughly elliptical—about 10 miles long and 3 miles broad at its widest part.

The only coal seam worked is the King seam which has an average thickness of about 5′-6″. The coal is first class steam coal used extensively by railways and mills.

The average analysis of the King seam coal is : —

Specific gravity 1.39.

		Per cent.	
Fixed carbon	..	55.85%	Calories 6433
Volatile matter	..	24.12%	B.Th.U's 11,580
Ash ..	..	14.17%	
Moisture	..	5.86%	

Formerly three pits were working at Singareni, *viz.*, :—

Strutt Pit, the largest in the group, 750 ft. deep, was equipped for an output of 1,500 tons a day.

No. 22 Pit and No. 23 Pit are 450 ft. and 350 ft. deep respectively and were equipped for 700 tons of daily output.

All the pits were equipped with modern machinery and laid out on up-to-date lines. The Strutt Pit was connected with Singareni Station by a $1\frac{1}{2}$ mile branch line. A large screening and picking plant was erected at Strutt Pit, whither the coal from No. 22 pit and Strutt Pit incline was conveyed by endless rope haulage on the surface. In addition to the above picking plant, a dry separator was also installed to deal with all small coal.

Pits Nos. 22 and 23 were connected underground and ventilated by a double inlet Sirocco fan capable of passing 250,000 c.ft. of air per minute capacity.

The Strutt Pit working was divided into four districts by solid coal barriers, thus ensuring good ventilation and isolation of fires and floods. Here also the ventilation was by means of a double inlet Sirocco fan, with 250,000 c.ft. per minute capacity.

The "pillar and stall" method of working was adopted, and the pillars varied from about 60 ft. by 60 ft. and 100 ft. by 100 ft. near the outcrop to 120 ft. by 140 ft. in the dip workings. Galleries were driven 12 ft. wide. The coal in these shafts was worked out by the end of 1941 and they were abandoned.

The Singareni Collieries worked steadily for nearly half a century and from 1889 to 1940 produced about 26 million tons of coal.

The Kothagudium Colliery started about the end of 1937. Since the exhaustion of the Singareni Collieries, this field has developed into a mining centre. This is connected with Karepalli on the Dornakal-Singareni branch by 25 miles of branch line. The coal seam worked here is the same King seam as at Singareni but without the thick interbedded bands. Besides this as at Singareni there is a thick seam above this which is however of a slightly poorer quality and is not at present being exploited. Besides the shaft at Birley pit two inclines have also been opened and named after Mr. Andrews.

The Singareni Collieries Co. Ltd., work the Singareni, Tandur and Kanala, and Kothagudium Collieries. The Sasti Colliery is being worked under the joint proprietorship of Sir Bisesar Das Daga and Sir M. B. Dadabhoy.

Besides the above, another important field was proved by prospecting conducted by Sir Fazulbhoy Currimbhoy to the south of the Godavary, forming the Jangaon coal field in which about 38 million tons of coal has been estimated. Continuing across the river in the Chinnur and Asifabad taluqs, surface indications of coal have been reported during the geological survey.

The prospecting license and mining lease granted to Sir Fazulbhoy Currimbhoy of Bombay over the South Godavary coal-fields in the Sultanabad taluq of Karimnagar district has since been transferred to Messrs. Singareni Collieries Co., Ltd.

Under the Hyderabad Mines Act, the Colliery Companies report all serious and fatal accidents by telegraph to the Director of Mines who immediately visits the site of the accident and conducts enquiries and submits a report to the Government. The returns of accidents are also forwarded to the Resi-

dency and the Chief Inspector of Mines in India.

Statements of output of coal produced and Royalty realised therein in the different collieries in the State are given below : (vide appendix ' A,' ' B,' ' C,' ' D,' and ' E.').

Coal and its by-products.—The utilization of the coal for briquetting, coking and low temperature carbonisation, are under the active investigation of the Government so that the raw materials may be used as economically as possible consistent with modern advancements in the coal industry as an aid to war efforts. The data on the physical and chemical properties of Hyderabad coals are given in the appended statement. (vide Appendix ' F,' ' G,' ' H,' and ' I ').

APPENDIX 'A.'

The Singareni Collieries Company, Limited.

Statement showing the total output raised at the Collieries since the commencement.

Year	Annual output			Progressive		
	T.	C.	Q.	T.	C.	Q.
1889	59,671	2	0	59,671	2	0
1890	125,470	18	0	185,142	0	0
1891	138,772	16	0	323,914	16	0
1892	125,656	11	0	449,571	7	0
1893	157,914	6	1	607,485	13	1
1894	240,524	17	2	848,010	10	3
1895	292,913	5	3	1,140,923	16	2
1896	262,880	8	3	1,403,804	5	1
1897	365,550	0	2	1,769,354	5	3
1898	394,621	16	0	2,163,976	1	3
1899	401,216	2	2	2,565,192	4	1
1900	469,290	19	3	3,034,483	4	0
1901	421,218	0	2	3,455,701	4	2
1902	455,423	17	3	3,911,125	2	1
1903	362,733	9	1	4,273,858	11	2
1904	419,545	12	1	4,693,404	3	3
1905	454,293	17	3	5,147,698	1	2
1906	467,923	16	2	5,615,621	18	0
1907	414,221	5	2	6,029,843	3	2
1908	444,211	18	2	6,474,055	2	0
1909	442,892	10	3	6,916,947	12	3
1910	506,173	3	1	7,423,120	16	0
1911	505,380	3	3	7,928,500	19	3
1912	481,652	3	1	8,410,153	3	0
1913	552,132	19	0	8,962,286	2	0
1914	555,990	14	1	9,518,276	16	1
1915	586,823	18	0	10,105,100	14	1
1916	614,519	19	0	10,719,620	13	1
1917	674,556	16	0	11,394,177	9	1
1918	647,486	16	0	12,041,664	5	1
1919	641,473	12	0	12,683,137	17	1

'APPENDIX A.'

The Singareni Collieries Company, Limited.

Statement showing the total output raised at the Collieries since the commencement.—(contd.)

Year	Annual output			Progressive		
	T.	C.	Q.	T.	C.	Q.
1920	666,334	10	0	13,349,472	7	1
1921	646,047	11	0	13,995,519	18	1
1922	604,357	14	0	14,599,877	12	1
1923	629,224	12	0	15,229,102	4	1
1924	619,725	0	0	15,848,827	4	1
1925	629,724	14	0	16,478,551	18	1
1926	609,745	4	0	17,088,297	2	1
1927	681,736	9	0	17,770,033	11	1
1928	699,150	6	0	18,469,183	17	1
1929	768,419	19	0	19,237,603	16	1
1930	765,490	10	0	20,003,094	6	1
1931	704,157	12	0	20,707,251	18	1
1932	719,937	13	0	21,427,189	11	1
1933	703,608	5	0	22,130,797	16	1
1934	727,756	12	0	22,858,554	8	1
1935	678,869	6	0	23,537,423	14	1
1936	799,149	14	0	24,336,573	8	1
1937	1,007,569	16	0	25,344,143	4	1
1938	1,120,381	1	0	26,464,524	5	1
1939	1,139,573	4	0	27,604,097	9	1
1940	1,178,945	4	0	28,783,042	13	1
1941	1,212,583	17	0	29,995,626	10	1

APPENDIX 'B.'

Output and Royalty on Coal from Singareni Collieries since 1889.

Year	Output			Royalty		
	T.	C.	Q.	O.S. Rs.	a.	p.
1889	59,671	2	0			
1890	125,470	18	0			
1891	138,772	16	0	1,07,260	0	0
1892	125,656	11	0			
1893	157,914	6	1	..		
1894	240,524	17	2	..		
1895	292,913	5	3	..		
1896	262,880	8	3	..		
1897	365,550	0	2	..		
1898	394,621	16	0	1,23,362	0	0
1899	401,216	2	2	1,16,246	0	0
1900	469,290	19	3	1,28,490	6	6
1901	421,218	0	2	1,37,809	5	0
1902	455,423	17	3	2,03,318	4	10
1903	362,733	9	1	1,75,098	3	10
1904	419,545	12	1	47,198	14	1
1905	454,293	17	3	51,108	1	0
1906	467,923	16	2	52,641	6	10
1907	414,221	5	2	46,599	14	4
1908	444,211	15	2	49,973	13	2
1909	442,892	10	3	49,825	6	7
1910	506,173	3	1	56,944	7	8
1911	505,380	3	3	56,855	4	4
1912	481,652	3	1	54,185	13	11
1913	552,132	19	0	62,114	0	0
1914	555,990	14	1	62,548	15	3
1915	586,823	18	0	66,017	12	0
1916	614,519	19	0	69,133	7	11
1917	674,556	16	0	75,887	10	4
1918	647,486	16	0	72,842	0	0
1919	641,473	12	0	72,165	12	5
1920	666,334	10	0	74,962	10	1
1921	646,047	11	0	72,680	5	9
1922	604,357	14	0	67,990	3	10

APPENDIX 'B.'

Output and Royalty on Coal from Singareni Collieries since 1889.

Year	Output			Royalty			
	T.	C.	Q.	Os.	Rs.	a.	p.
1923	629,224	12	0		70,787	12	3
1924	619,725	0	0		69,719	1	0
1925	629,724	14	0		70,844	0	6
1926	609,745	4	0		68,596	5	4
1927	681,736	9	0		76,695	5	7
1928	689,019	16	0		77,514	11	8
1929	742,213	9	0		83,499	0	2
1930	713,056	9	0		80,218	13	7
1931	657,627	13	0		73,983	1	10
1932	593,466	4	0		66,764	15	2
1933	519,442	15	0		58,437	5	0
1934	527,989	2	0		59,398	12	5
1935	513,259	6	0		57,741	10	9
1936	606,106	14	0		68,187	0	0
1937	740,769	17	0		83,336	9	9
1938	690,850	6	0		77,720	10	6
1939	676,513	7	0		76,107	12	0
1940	539,943	9	0		60,743	10	2
1941	154,164	5	0		17,343	7	8

APPENDIX 'C.'

Output and Royalty on Coal from Tandur Collieries since 1928.

Year	Output			Royalty			
	T.	C.	Q.	O.S. Rs.	a.	p.	
1928	10,130	10	0	2,112	1	11	
1929	26,206	10	0	4,932	8	2	
1930	52,434	1	0	10,087	4	10	
1931	46,529	19	0	4,275	11	7	
1932	126,471	9	0	24,018	13	8	
1933	184,165	10	0	41,257	1	11	
1934	199,767	10	0	40,446	3	1	
1935	165,610	0	0	37,879	2	0	
1936	193,043	0	0	44,653	12	7	
1937	265,624	0	0	63,195	5	2	
1938	334,283	0	0	80,854	6	0	
1939	313,155	0	0	74,953	9	7	
1940	321,299	0	0	76,309	14	2	
1941	347,201	0	0	82,531	4	2	

APPENDIX 'D.'

Output and Royalty on Coal from Kothagudium since 1937.

Year	Output			Royalty			
	T.	C.	Q.	O.S. Rs.	a.	p.	
1937	1,175	19	0	11,044	0	0	
1938	95,247	19	0	22,576	3	0	
1939	149,904	17	0	..			
1940	317,702	15	0	61,505	0	0	
1941	711,218	12	0	1,67,612	0	2	

APPENDIX 'E.'

Output and Royalty on Coal from Sasti Collieries since 1916.

Year	Output			Royalty		
	T.	C.	Q.	O.S. Rs.	a.	p.
1916	770	3	2	96	4	4
1917	6,073	0	0	759	2	0
1918	11,634	15	0	1,454	5	6
1919	20,722	10	0	2,590	5	0
1920	27,745	5	0	3,468	2	6
1921	42,673	15	0	5,334	4	6
1922	38,522	5	0	4,815	5	6
1923	29,204	5	0	3,650	8	6
1924	29,049	10	0	3,131	3	0
1925	38,152	15	0	4,769	1	6
1926	28,033	15	0	3,504	3	6
1927	25,477	0	0	4,638	3	0
1928	35,615	5	0	7,973	11	10
1929	47,455	9	0	10,971	7	7
1930	46,808	19	0	10,609	14	2
1931	53,417	5	0	12,371	0	0
1932	61,184	16	0	14,347	15	9
1933	49,793	14	0	11,510	3	0
1934	42,940	16	0	9,621	5	2
1935	50,585	19	0	11,615	0	7
1936	53,589	7	0	12,352	2	0
1937	68,670	14	0	16,045	13	0
1938	90,782	4	0	21,556	3	7
1939	74,994	16	0	17,607	9	5
1940	71,176	18	0	16,534	11	6
1941	88,793	15	0	20,792	13	7

APPENDIX 'F.'

4. *Carbonisation Assay by Grey-King Apparatus.*

Assay temperature			575° C.
Yield per 100 gm. of dry coal :			
Coke	..	gm.	60.86
Tar	..	gm.	5.82
Liquor	..	gm.	6.00
Gas (by difference)	..	gm.	7.81
	Total	gm.	99.95
Ammonia (NH_3)	..	gm.	0.057
Gas (26°C and 68.3 saturated)	..	c.c.	7,800
Character of coke			Black powder
Behaviour on distillation :			
First appearance of oil vapour	..	deg. C.	410 C.
Rapid evolution of gas	..	deg. C.	460 C.

5. *Swelling Power.*

Swelling power has not been determined in view of the non-coking character of the coal.

6. *Tar Tests.*

Tar was distilled in a specially designed oil-fired furnace in a horizontal, cylindrical retort at 900°C.

Yield in grams per 10 lbs. of coal (accuracy of the yield being within 5 per cent.)	..	160
Specific gravity—S 25°C/25°C,	..	1.0474

APPENDIX 'G.'

4. *Carbonisation Assay by Grey-King Apparatus.*

Assay temperature		575°C.
Yield per 100 gm. of dry coal :		
Coke	.. gm.	77.00
Tar	.. gm.	9.41
Liquor	.. gm.	6.50
Gas (by difference)	.. gm.	7.04
Total	.. gm.	99.95
Ammonia (NH_3)	.. gm.	0.052
Gas (6°C and 68.3 saturated) ..	..c.c.	8,300
Character of coke	Very loose lumps which fall to powder on mere touching	
Behaviour on distillation :—		
First appearance of oil vapour ..	deg. C.	410
Rapid evolution of gas ..	deg. C.	450

5. *Swelling Power.*

Swelling power has not been determined in view of the non-coking character of the coal.

5. *Tar Tests.*

Tar was distilled in a specially designed oil-fired furnace in a horizontal, cylindrical retort at 999°C.

Yield in grams per 10 lbs. of coal (accuracy of the yield being within 5 per cent.)	265
Specific gravity—S 25°C/25°C.	1.0839

APPENDIX 'H.'

4. *Carbonisation Assay by Grey-King Apparatus.*

Assay temperature		575°C
Yield per 100 gm. of dry coal :		
Coke	.. gm.	75.18
Tar	.. gm.	9.33
Liquor	.. gm.	7.00
Gas (by difference)	.. gm.	8.43
Total	.. gm.	99.94
Ammonia (NH_3)	.. gm.	0.066
Gas (26°C and 68.3 saturated) ..	.. c.c.	8,500
Bahaviour on distillation :		
First appearance of oil vapour ..	deg. C.	390
Rapid evolution of gas ..	deg. C.	460

5. *Swelling Power.*

Swelling power has not been determined in view of the non-coking character of the coal.

6. *Tar Tests.*

Tar was distilled in a specially designed oil-fired furnace in a horizontal cylindrical retort at 900°C.

Yield in grams per 10 lbs. of coal (accuracy of the yield being within 5 per cent.)	240
Specific gravity—S 25°C/25°C	1.0755

APPENDIX 'I.'

4. *Carbonisation Assay by Grey-King Apparatus.*

Assay temperature			575°C
Yield per 100 gm. of dry coal:			
Coke	..	.. gm.	75.74
Tar	..	.. gm.	8.86
Liquor	..	.. gm.	7.50
Gas (by difference)	..	.. gm.	7.83
	Total	.. gm.	99.93
Ammonia (NH_3)	..	.. gm.	0.073
Gas (26°C/ and 68.3 saturated)		.. c.c.	8,500
Character of coke			Black powder
Bahaviour on distillation.			
First appearance of oil vapour	..	deg. C.	400
Rapid evolution of gas	..	deg. C.	450

5. *Swelling Power.*

Swelling power has not been determined in view of the non-coking character of the coal.

6. *Tar Tests.*

Tar was distilled in a specially designed oil-fired furnace in a horizontal, cylindrical retort at 900°C.

Yield in grams per 10 lbs. of coal (accuracy of the yield being within 5 per cent.)	.. ..	210
Specific gravity—S/25°C/25°C	.. ..	1.0955

2. *Mica.*

In parts of Armur taluq, Nizamabad district, muscovite mica has been noted in pegmatites in association with tourmaline in the zone of contact with argillaceous sediments. Mica occurs in flakes and books about $1\frac{1}{2}$ to 2″ square.

Mica of commercial sizes occurs at Kappalbandam and Batalpalli near Kallur, Madira taluk, in Warangal district. Here mica occurs in the pegmatite veins intrusive in the boitite or hornblende gneisses. The maximum size of the mica seen in the blocks is $1'' \times 1''$ and some $2'' \times 2''$. In the waste mica lying about the dumps of excavations the sizes $3'' \times 3''$ are frequent, some $4'' \times 4''$ and the largest $6'' \times 4''$. The mica is clear and the books do not split into regular sheets. There are about 170 tons of the scrap mica lying about in the dumps, which may have a market in micanite and mica dry-lubricant industries.

In parts of Raichur Doab, muscovite mica has been noted in the following localities :—

(1) Near Yebbalu in Gangawati taluq there are old workings for mica in pegmatite. The size of the mica is about an inch square. The trial pits by some previous prospectors to the north of the village contain rock debris, where mica even 4″ square was obtained in pegmatite.

(2) About half a mile south of the Tawargeri-Kushtagi road, mica-bearing pegmatites associated with quartz veins occur. The average size of some of the surface specimens is about $1\frac{1}{2}$ inches.

Small size mica and flakes are now in demand for making micanite and for dry lubrication along with graphite.

In 1916 a prospecting license for mica near Hebbal in Gangawati taluq, was issued to Nadvi Timmayya who obtained a mining lease in 1917 for ten years. But as the size of mica was small and there was no market for it, further mining operations were not conducted.

Mr. Pratapaswami was given a prospecting license for mica in Devanpalli in Raichur taluq in 1917 and in 1921 obtained a mining lease. As there was no demand for the small size mica, further mining had to be abandoned.

The Hyderabad (Deccan) Co. obtained a mining lease for mica in Kallur area in 1927, but surrendered the lease in 1936.

3. *Graphite.*

Graphite, one of the natural forms of carbon, known in commerce as plumbago or black-lead, is recognised in two forms, *viz.*, (1) crystalline or flake graphite, and (2) amorphous graphite when mixed with clay, silica and other impurities. Graphite has wide industrial applications for the manufacture of crucibles used for melting metals. It has a large use in the manufacture of ' lead ' pencils, in paints, for the prevention of scale formation in boilers, for stone polishing, electrodes and batteries. It is an excellent lubricant in the dry state as well as mixed with lubricating oil to reduce friction between metallic surfaces.

Graphite is reported in veins from a few inches up to two feet in width from Paloncha in Warangal district in garnetiferous gneiss. The graphite is much impregnated with earthy material. Good quality graphite is also reported from the area and an improvement both in quality and quantity in depth is indicated by excavation work. The following are

the results of the analyses of graphite in crude, powder and in refined flakes from Paloncha.

Graphite crude :	*Per cent.*
Volatile matter ..	6.30
Fixed carbon	31.30
Ash	62.40
	100.00

Graphite powder.	*Per cent.*
Volatile matter ..	6.50
Fixed carbon	32.05
Ash	61.45
	100.00

Graphite refined flakes.	*Per cent.*
Volatile matter ..	2.35
Fixed carbon	76.55
Ash	21.10
	100.00

A small deposit of graphite is reported from near Hasanabad, Karimnagar district.

In 1919, a mining lease for Paloncha graphite was granted to Mr. Gulam Habib Khan who transferred the lease to Messrs. Nizamuddin and Lantyn in 1921. In turn the latter transferred the lease to Mr. R. S. Chenoy. Mr. Rasheed Chenoy, who was granted the mining lease in 1934, has entered into an arrangement with Messrs. The Gouthami Mining Works of Kovvur, who are now carrying on mining operations.

The following is the quantity of graphite produced since mining began :

Output of Graphite from Paloncha area from 1344 *F. to* 1347*F.*

Year	Output Tons.	Cwt.	Qrs.
1344 Fasli	21	10	3
1345 ,, ...	6	8	2
1346 ,, ...	85	12	1
1347 ,, ...	26	4	1

4. *Talc and Soapstone.*

Talc, either as the foliated or the massive variety, occurs in various parts of the State, mainly in altered ultrabasic rocks, rich in magnesia.

Talc schists are often found in the talc-chlorite series of the Dharwars of the Raichur Doab. Fine bands of talc occur fringing the ferruginous quartzitic bands near the 20th milestone on the Lingsugur-Tawargeri road and also in the Parampur schists belt, Lingsugur taluq, Raichur district.

Varieties of potstone, locally known as "bulpham," are reported from Maitpalli in Karimnagar district and Damenapalli in Warangal district, also as an alteration product of amphibolitic rocks at Chootpalli, Armoor taluq.

Impure varieties of soapstone were also observed near Abhangapatan in Makhtal taluq and at Arewatla and Lamur in Atraf-i-Balda.

Soapstones occur in the Dharwar schists patch near Malkapalli, Seram taluq, Gulbarga district, where a small ridge is wholly composed of this material.

Talcose rocks have been noted in Singareni village lands of Yellandu taluq, Warangal district. These are used by the local school-boys as slate pencils and for the making of inkstands, geometrical models, etc.

On the Kamepalli-Jestaipalle track in Yellandu taluq of Warangal two small ridges are composed of talcose rocks.

Soapstone is quarried near Turkal Muddi Kunta, Peddapalli Jagir, Karimnagar district. The material is being used in the Sirpur Paper Mills.

Some amphibolite dykes near Rajed Mailwaram, Vodcherla, Kollur and Lackcherla in Chincholi taluq alter to talc which appear to be adequate to support minor cottage industries.

About two miles to the north west of Kulkulapalli in the hill (Trig. point 2041) along its eastern flank, Miryalguda taluq, Nalgonda district, talcose rock is locally quarried and the material is carved into stoneware by the local blacksmiths who ply a trade on it on a small cottage industry basis. But due to cheaper imported ware this craft is practically disappearing.

Powdered talc is an important mineral 'filler' used in industry. The best grade is used in the manufacture of toilet powders and certain types of soaps and also in the leather and rubber industries and in the manufacture of foundry facings and metal polishing work. The cut soapstone products like "slate-pencils" and markers, are used in the tailoring trade, etc.

5. *Fluorite.*

Fluorite has been found associated with galena in the pink granites, in Devarkonda taluq; this sometimes also occurs in branching veins in the granites.

But, however, while prospecting for galena the mineral has been found only in a small quantity. Commercially, fluorite has its largest use as a flux in open-hearth furnaces, in metallurgy and also in the manufacture of hydrofluoric acid. In the ceramic industry as a constituent of enamels, for metal glazes, for porcelain and opalescent glass, fluorites also finds an extensive use.

6. *Calcite.*

Calcite veins occur in the hornblende schists to the north of the road from Wandalli to Hutti in Raichur district. A large number of calcite veins in the galena area of Devarkonda taluq have also been observed. Veins of calcite ranging from thin stringers to $2\frac{1}{2}'$ in width have been noted in association with galena near Mallapalli and Pedda Adisarlapalli in Devarkonda taluq. The use of pure limestones (above 94 per cent. of $CaCO_3$) as a raw material for the manufacture of bleaching powder has recently been advocated by Geological Survey of India. The question of utilising this calcite in the bleaching-powder industry deserves investigation. The associated galena might then perhaps find a value as a by-product in the mining of calcite.

7. *Serpentine.*

Serpentinous materials derived from the alteration of amphibolites occur near Zupalli, Kalvakurti taluq in Mahbubnagar district. Old excavations are met with in the area. There is a marked development of pinite at the contact of granite with the quartz veins.

Highly altered basic dykes give rise to serpentinous bands near Bothlapalem, Miryalguda taluq, Nalgonda district. The rock is used for making stoneware and pots to meet local demands.

8. *Zeolites.*

Zeolites occur abundantly in the amygdaloidal layers of the Deccan Trap areas of the State in geodes and cavities and may be commercially exploited for softening and purifying water in town water supply schemes.

9. *Barytes.*

Float barytes have been picked up at Wazirabad, Miryalguda taluq, Nalgonda district in the bed of the Kistna near its confluence with the Musi. But no in-situ beds or veins of barytes have been reported.

10. *Semi-precious Stones.*

Amethyst, chalcedony, opal, onyx, jasper, bloodstone, plasma, agate *etc.*, occur as widely scattered amygdules in the Deccan Traps. Streams and rivers flowing through such trap areas are a fruitful source for these materials for the lapidary industry.

Cherts and other varieties of amorphous silica occur extensively in Gulbarga district. These are of pleasing colours, and would furnish raw materials for the lapidary industry and ornamental ware.

Some of the localities for cherts are enumerated below :—

1. Massive beds of cherts of yellow, pink and other colours occur interbedded in Bhima limestones between Hugratgi and Thirth in Surapur taluq. Similar cherts are found between Mallakhurd and Halbhavi in Shahpur taluk.

Cherts associated with intertrappean beds occur in the following localities :—

1. Between Hagargundgi and Bahat Saturgi in Gulbarga taluq.

2. In the Kagna valley west of Shahabad.

3. Yelwanti Khurud, Sevalga, Kalmud, Antaphad, Ankalga in Gulbarga taluk.

4. On the Gurmatkal plateau in Yadgir taluq.

5. Between Raichur and Medak in Kodangal taluq.

6. In the village lands of Kalgi, Kudhalli, Sulphet, Chimaidlai, Dastapur, Yakatpur, in Chincholi taluq and in the trappean cliffs near Vikarabad and Pargi.

Pebbles of agate, chalcedony, plasma, onyx, cornelian, etc., are found in a calcareous conglomeratic bed between Herur Buzurg and Ferozabad.

Amethystine quartz is occasionally found in quartz veins in granitic areas. They are found as crystal aggregates near Pedda Gowraram, and Pothapalli in Yellareddi taluq, Nizamabad district. Some good specimens have been collected from Bhongir taluq.

Garnets.—Translucent and transparent varieties of red almandine garnets of Garibpet area, in Madira taluk, have long been known to yield materials for the lapidary industry. The Hyderabad (Deccan) Company, who held a lease over this area, used to select such clear varieties, which had a ready market in Madras.

Long platy crystals of kyanite are also found associated with garnets in this area.

IV. MATERIALS FOR INDUSTRIAL APPLICATION.

(*a*) Paints and Distempers.

1. *Ochre.*

Variegated ochres, ochreous lithomarge, and bole suitable for pigments, occur in various parts of the

State. The chief deposits are found in association with Dharwar magnetite-hæmatite schists and in the Deccan Trap laterite areas. In the Kushtagi band of ferruginous quartzites ochreous deposits of reddish, chocolate, purple and yellow limonitic varieties are commonly obtained. The materials, fine in texture, not requiring much sifting, is mostly used for painting mud walls and wooden structures of the village houses.

Ochre of fine quality and colour in various shades of scarlet, purple, chocolate, yellow, *etc.*, is reported from laterites. There is an abundant supply of this raw material for the paint industry which may find a suitable use in the Hyderabad Paint Factory (The Deccan Paint Works).

A mining lease for red ochre was granted to Mr. Rajaji Kista Goud in 1917 in the Osmanabad area, which was transferred by the lessee in favour of his four sons in 1918. But as no work was done the mining lease was cancelled in 1921.

Ochre beds 9″ to 18″ thick occur as lenses and patches in the variegated clayey layer about 45′ thick below the vesicular lateritic masses capping the Deccan Trap hills near Vikarabad. These lenses may be considered to be in almost continuous beds of an average thickness of 12″. The variegated layer contains grey, yellow, reddish, bluish and white clay. The hills of Pirampalli, Yelchal, Timmareddipalli and Ekmamidi contain a large quantity of ochreous material. On a conservative estimate about 51,000 tons of red ochre and 10,200 tons of yellow ochre are reported. The results of analysis of the samples from these localities indicate their possible wide utilisation for paints, distempers, oil refining, ceramic and allied industrial purposes.

Extensive beds of ochreous shales underlie Deccan Trap in the western parts of Andola taluq and are

exposed all along the scarp of the plateau for over 20 miles. They vary in thickness from 5 to 15 feet and are pronounced to be suitable in paint and distemper. On a conservative estimate 250,000 tons of material can easily be obtained.

Crude hæmatitic shales with an average of over 60 per cent. Fe_2O_3, occur interbedded in the mud shales between Bankur and Chitapur in Gulbarga taluq. They have a rich vermillion streak, and require to be ground before they can be used for paints. About one thousand tons of the material are available as surface spread, but much larger quantities could be obtained if quarrying is resorted to.

Minor deposits of ochre occur at Mallur in Surapur taluq, Chopatla and Uanagundi in Yadgir taluq of Gulbarga district.

2. *Laterite and Aluminous Boles.*

Both high and low-level laterites are met with within the State, covering wide areas of the upper layers of the Deccan Trap. This is also met with on gneissic areas developed under semi-arid and tropical conditions. Extensive formations of laterite in Bidar, Vikarabad, parts of Nizamabad and Asifabad districts have been noted as a former source of iron. The ratio between the iron oxide and alumina varies considerably, so that the laterites approximate on the one hand to low grade iron-ores, and on the other to bauxite. So far no true bauxite has been reported from the State. The percentage of iron oxide in the Nizamabad laterites varies from 13.9 to 60.98 and that of alumina from 0.55 to 36 per cent. Samples of aluminous bole from Goorjakuntla, Kamareddi taluq and Kyrtlapalli in Yellareddi taluq assay 25.5 and 36.3 per cent. of Al_2O_3 respectively. These boles are whitish to purplish blue in colour and consist

of fine aluminous material from which most of the iron-oxide has been eliminated.

At Godkal and Basiralagutta of Rawatla in Armoor taluq bluish aluminous clay galls occur associated with lithomarge in lateritoid accumulations.

The analyses of twelve specimens of laterites from Vikarabad area referred to by Knight Hallowes disclose a range in iron from 17 per cent. to 43 per cent. including titanium, the average being 34 per cent. Twelve other analyses of laterites from the Department show a range of 36 per cent. to 50 per cent. iron. The silica percentage ranges from 18 per cent. to 40 per cent., showing that lateritisation is not complete.

(*b*) Ceramic Industry.

1. *Kaolin.*

(See section under clays page 87).

2. *Felspars.*

Felspars occur in abundance widely distributed throughout the Peninsular Gneissic Complex area, particularly in pegmatites. Such pegmatites in veins tabular masses and sheets are extensive in and adjoining Dharwar bands.

For ceramic purposes potash and soda varieties of felspar are employed and although they may have high chemical purity, a mere chemical analysis alone may not indicate their usefulness. Due to the fact that there has been no market for felspar and kindred materials no proper search has been made so far for suitable deposits but it should always be borne in mind that a source of felspathic material of good quality is a necessary desideratum for pottery work.

The following are places in the Raichur, Mahbubnagar and Gulbarga district, where felspars have been located in abundant quantity.

1. In the neighbourhood of Matmari, Partipalli and Turkandoddi, Raichur taluq (Matmari is a Rly. Station, south of Raichur, M.S.M. Rly).

2. Between Basanapalli and Mamunapur (Makhtal taluq) Mahbubnagar district.

3. Near Kotakonda, about 10 miles east of Narayanpet, Makhtal taluq, Mahbubnagar district.

4. Between Bhairapur and Siddapur in Surapur taluq, Gulbarga district.

It is reported that the felspars of Matmari, Turkandoddi and Tungabhadra have commercial value. None of the localities have been examined with a view to determining their actual quantity.

A few areas for felspars from Devarkonda and Miryalguda taluqs may be mentioned. But these, too, have not been prospected. Here the felspars may be hand-picked or easily separated from the pegmatites containing quartz and felspar.

1. North-west of Nidmanur, Miryalguda taluq, Nalgonda district (about 25 miles on the Miryalguda-Devarkonda road).

2. North of Damarcherla, Miryalguda taluq, Nalgonda district (Hyderabad-Masulipatam road, about a mile east of 101 mile-post).

3. About a mile to the south of Charakonda, 16 miles from Kalvakurthi on the Devarkonda road.

Pegmatite veins in the vicinity of Hyderabad :—

1. Felspar veins of good qaulity and size are available on the Himayatsagar road 6 miles from Hyderabad in association with a quartz reef.

2. A bulge of quartz and felspar veins, about 15′ high, constitutes the Red Hill, near Nampalli Railway Station, where a workable quantity of felspar is easily obtainable.

(*c*) Glass Industry.

Quartz.

The raw materials for the manufacture of glass are silica in the form of powdered quartz or sand and alkali as sodium carbonate (soda ash) or sodium sulphate. If lime is added, a less fusible and harder glass results. Borax is often used when clear optical glass is desired.

The requisite primary raw materials are available in large quantity in the State to encourage a glass industry, provided the products can stand competition in the market. Quartz occurs abundantly as reefs and veins in the granite complex, and in the purer types of quartzites and sandstones in the sedimentaries. Brine and saline efflorescences, particularly in parts of Yadgir and Makhtal tāluqs, yield sodium carbonate and sulphates which may be easily separated from other impurities for fluxing.

A glass and bangle-making industry has long been in existence in the State and indigenous glass-works are still seen near Gazulapet and Manikonda, etc., testifying to a flourishing condition of this industry in times past. This crude method of manufacture without modern equipment has received a set-back due to the influx of cheap foreign material which has swamped the market and given a death-blow to this ancient cottage industry. It is encouraging to note that a glass factory has been started near Hyderabad and its development is watched with interest. With the abundance of raw materials and the encouraging

progress shown by the existing factory, it is hoped that ere long, new enterprises in this line will be started.

Quartz of the requisite purity may be easily obtained from quartz veins and reefs distributed throughout the granitic areas of the State.

Shadnagar group of quartz reefs.—The following group of white quartz veins is reported from near Shadnagar (Chitampalli) Railway Station.

Shadnagar quartz sample yielded.

SiO_2	..	97.08%
Fe_2O_3	..	0.79%

The quartz is almost pure white and the estimated quantity is over 200,000 tons.

(1) The largest, nearest Shadnagar Station, is 3 miles west of the Railway Station and six furlongs east of Elkatta, with a NNE-SSW trend and running parallel to the road to Shahabad. This reef is over 600 ft. long, about 300 ft. wide and has an average height of 10 ft.

(2) The second quartz reef is about a mile south-west of the Elkatta reef, south of the village Malayakatta ($4\frac{1}{2}$ miles west of the Railway Station). This caps a granite hill and is over half a mile long along its strike. The available quantity is much more than in the Elkatta reef.

(3) A third occurs about half a mile south-east of Mughalgidda, south of the 5 mile 1 furlong and 5 mile 5 furlong stones on Purgi road.

(4) The fourth occurs to the north and south of the 8 mile 1 furlong stone on the same road. (Elkatta is 35 miles by road from Hyderabad and Shadnagar is 37 miles by rail from Secunderabad).

(5) Similar quartz reefs occur in Bawanpalli village lands in Purgi taluq. The place is about 4 miles south of Gadisingapur on the Purgi-Kodangal road. It is estimated that there are about a hundred thousand tons of good quartz in this area.

Quartz Reefs near Hyderabad.—Knight Hallowes has mapped a large number of quartz reefs and veins in the neighbourhood of Hyderabad ; only the more important ones are enumerated below. Quartz from these reefs has not been analysed.

1. A large quartz reef extends northward for about 6 or 7 miles from near the 32 mile-stone on the Mahbubnagar line.

2. A group of smaller reefs occurs 4 miles east of Timmapur Station near Aminpet.

3. A large quartz reef occurs about 2 miles west of Shamshabad and extends for about 4 miles northwards up to the Himayat Sagar tank where it disappears to outcrop again near Himayat Sagar village further north and then runs for another two miles across the Vikarabad road. A group of smaller quartz veins occurs a little to the east of this near Vikarabad.

4. A quartz reef outcropping near the 105 mile-stone on the Wadi line extends northwards for more than 2 miles west of Kukutpalli on the Secunderabad-Sangareddipet road.

5. A quartz reef runs parallel to the Medchal road through the cantonment area west of Bolarum for about 2 miles.

The quartz reef at the 12 miles 4 furlongs mile-stone, Hyderabad-Sangareddipet road, was prospected and, on a conservative estimate, the average width may be taken as 85′, the average height at 15′ to 20′ with a reef length of about 2 miles.

The quartz is of good quality and the results of analysis are as follows :—

		Per cent.
Picked specimen	SiO_2	..99.31
A	Fe_2O_3	.. 0.17
		99.48
Average bulk sample	SiO_2	..99.10
B	Fe_2O_3	.. 0.20
		99.31

It is reported that quartz ' A' and ' B ' are suitable for the manufacture of glass.

Besides quartz reefs, the sandstone beds from near Kodangal give the following analytical results.

	Per cent.
SiO_2 ..	96.20
Al_2O_3 ..	2.90
Fe_2O_3 ..	0.08
	99.48

This sandstone is reported to be suitable for the manufacture of a cheap type of glass-ware.

The sandstone belt in the Bhima Series occurs for a total run of 10 miles from the east of Srinivasapur to north of Kodekal in Surapur taluq of Gulbarga district ; an average working thickness of 15′ without overburden and a lateral extent of 300 ft. from the scarp may be safely assumed to gauge the available quantity of the sandstone.

(*d*) Cement Industry.

The Purana sedimentaries of the Bhima and the north Kistna basins afford material for cement manufacture. The Director of Mines during the year 1919-1923, conducted a detailed survey and prospecting of the Shahabad limestone area in connection with the proposal for starting a cement factory by Messrs. Tata Sons & Co. Raw materials were proved, sites for wells for water-supply located and a suitable site for the Factory was selected. The limestones and shales near Shahabad yield excellent materials and a cement factory is working very successfully at Shahabad controlling most of the South Indian market. The Mettur Project drew its cement supply only from this factory. The statement in appendix ('J') gives the output and royalty on cement manufactured in the Shahabad works between 1925 and 1938.

Limestones assaying on an average 87 per cent. $CaCO_3$, with negligible traces of magnesia and iron, are obtained at Wazirabad in Nalgonda district. Shales of the required quality are also found extensively.

The Bhima limestones on the west of Surapur taluq are suitable for cement manufacture and a specimen from the Yedihalli-Hebbal plateau assayed as follows :

		Per cent.
$CaCO_3$	..	92
$MgCO_3$	..	1.20
Insoluble (mostly silica)		6.80
Fe	..in traces.	

As there is no dearth of iron-free limestones and shales suitable for cement manufacture in the Bhima and the Kistna basins, a wide opportunity for extensive development of this industry is afforded.

APPENDIX "J."

Output and Royalty on Cement produced at Sahahabad since 1925.

Year	Output	Royalty		
	Tons	B.G. Rs.	a.	p.
1925	4,003	3,002	4	0
1926	28,347	21,260	4	0
1927	44,358	33,268	5	0
1928	45,199	33,899	4	0
1929	72,263	54,197	4	0
1930	89,948	67,461	0	0
1931	131,808	98,856	0	0
1932	128,939	96,704	4	0
1933	99,287	74,465	4	0
1934	99,752	74,814	0	0
1935	114,289	85,716	12	0
1936	127,793	95,844	12	0
1937	143,850	1,07,887	8	0
1938	141,606	1,06,204	8	0
1939	134,621	1,00,965	12	0
1940	130,785	98,088	12	0
1941	146,780	1,10,085	0	0

V. SALT DEPOSITS.

(*a*) *Common and Tanning Salts.*

Common salt in brine frequently occurs in the neighbourhood of Dharwar rocks at or near their contact with gneisses, particularly with pink pegmatites in the Raichur Doab, parts of Gulbarga and Mahbubnagar districts and also in other western areas where arid conditions prevail. A local salt industry has been carried on in such areas from a very long time and even now this exists in a struggling condition. Two varieties of salt are produced, *viz.*, edible and "tanning." The important centres of salt manufacture along saline *nullahs* are located in the, (1) Sarjapur-Guddinhal zone, (2) Sindhnur zone, and (3) Lingsugur and Raichur taluqs in the Raichur Doab. Such salt works are also sporadically distributed in other parts of the district, specially in Manvi, fringing the Dharwar belt.

An important centre of salt production is the Baichbal area, Surapur taluq, Gulbarga district. By far the greatest quantity of edible salt is produced here. The Agni *nullah*, which is particularly saline, is a promising centre for locating a cottage industry. Shahpur, Yadgir and Makhtal also contribute considerably to the output. For purposes of local consumption, edible salt is manufactured to a greater extent than tannery salts. With a view to placing this dying cottage industry on a sound economic basis, an extensive survey of the saline areas of these districts was conducted and investigations on the quality and quantity of brine in the test area in Sarjapur, were carried on and experiments on a quicker process of production by stack evaporation completed. The production, as the figures show, if properly developed, will no doubt increase considera-

bly and meet at least the local demand. Typical edible and tanning salts give the following analysis :—

	NaCl	Na_2SO_4	$MgSO_4$	$MgCl_2$	HO_2	$CaCO_3$	$CaSO_4$
	Per cent.						
Edible salt ..	96.45	1.23	..	0.72	1.6	..	..
Tanning salt	37.9	42.11	11.45	..	..	7.6	.8

It may be borne in mind that even with the best efforts, an increased output can only supply a portion of the State.

The possibilities of increasing the output of tanning salt is much wider, as it appears that most of the weak brines which lie unexploited may in future be utilised under improved methods of production. The tanning salt is much in demand for curing raw hides in Raichur, Warangal, Aurangabad and other places. An increased and steady output will always find a ready market.

[*Statement.*

The average annual production of the edible and tanning salts obtained in different centres at the time of investigation is summarised as follows :—

	Edible salt in bags of $2\frac{1}{2}$ Mds.	Tanning salt in bags.
Surapur	5,200	1,500
Shahpur	454	..
Yadgir	457	..
Makhtal	403	65
Raichur	2,550	560
Deodrug	800	60
Gurgunta	3,000	2,000
Lingsugur	1,220	1,350
Kushtagi	20	..
Gangawati	284	..
Sindhanur	2,894	1,560
Manvi	1,116	312
Alampur	..	..

Detailed reports* on salt and the possibilities of its future development have been given in the departmental publications and in the publications of the Commerce and Industries Department. Associated with the common salt, as revealed by chemical analyses, there are sodium sulphate, magnesium chloride, calcium sulphate, magnesium sulphate, calcium carbonate, *etc.*, which occur either in the brine or in the saline efflorescent crusts of the soil. If the local salt industry is placed on an economic footing with an increased output, these salts, separated by fractional crystallisation, would undoubtedly find

*J.H.G.S., Vol. II., Pt. 1., Vol. III., Pt. 2., (pp. 1-23). Bull. No. 11 C. & I. Department (pp. 1-26).

a ready market and yield a greater return than ordinary crude tanning salt can pay.

In parts of Yadgir and Makhtal taluqs, saline efflorescences in the *nullah* basins produce a good percentage of sodium sulphate and carbonate, locally known as "Soudu." These, on treatment supplies soda for the manufacture of glass in the local industry which is being carried on from ancient times.

With improved methods of separation and manufacture of soda and facilities for glass-making on modern lines, the ancient glass and bangle-making industry should naturally find a new impetus.

(*b*) *Saltpetre.*

Saltpetre as a natural deposit has not been reported in the State but it is manufactured from the scrapings of earth taken from under the refuse heaps of old village sites where it has accumulated through the ages. The manufacture of nitre is even now carried on at Maski, Mudgal, Sindhanur, Koratgi, Manvi, Watgal, Gabur, Hirebodur, Santikellur, Kotankal and other areas in the Raichur Doab and at a number of localties in Surapur taluq, particularly at Kembhavi, Yalgi, Kudligi and in several localities in Makhtal and Andola taluks. The crystallised salt is mostly utilised within the State for making fireworks and gunpowder.

In old villages like Pedda Adisarlapalli and Gundlapalli in the Devarkonda taluq, nitre is also locally manufactured by lixiviation methods from the material derived from the village refuse heaps. The material readily finds a market in Madras.

The production of nitre in these places is strictly limited, dependant as it is on the uncertain source of supply of raw material locally obtained.

(c) *Dhobie's Earth.*

In low swampy areas, along *nullah* basins where wild date and toddy palm flourish luxuriantly and in the bed and banks of dry tanks, a white alkaline earthy encrustation formed after the rains is scraped up by the local dhobies for washing purposes. This efflorescent earth consists mostly of carbonate of soda, sodium sulphate and a subordinate quantity of sodium chloride and magnesium chloride. The soda-earth is also used in making soda-ash for the glass-bangle industry. (See Section on salt).

VI. CLAYS.

(a) *Kaolin.*

The word 'kaolin' is used for two types of white clay, the one being decomposed felspar and the other a white sedimentary clay of fine texture and usually more plastic owing to the colloidal clayey matter it contains. The former is only slightly plastic as it is essentially kaolinite which is crystalline, containing varying proportions of other minerals, chiefly quartz, felspar and mica, as impurities. A washing process must be carried out to eliminate these undesirable impurities. In the trade the washed product is known as china clay.

A good kaolin is highly refractory and is characterised by a clean white colour in the natural and fired condition, by a maximum of free silica content of 10 per cent., and a very small content of iron oxide.

Abundant pegmatites and highly felspathic granites occur throughout the Peninsular Complex. The decomposition of the felspars produces materials ranging from unaltered felspathic grits to fine kaolinitic clay.

An important deposit of kaolin is reported from Chintrala in Nalgonda district, where it occurs in beds associated with Purana shales. Roughly it is estimated that about 250,000 tons may be available in this area. This material is said to be of high grade for ceramic purposes—comparable with other high grade foreign kaolin. A sample from this locality gave the following analysis :—

Silica ..	69.30%
Al_2O_3 ..	26.10%
CaO	0.80%
MgO	0.50%

Iron was detected in very small traces and the sample is practically free from carbonates of calcium and magnesium.

A mining lease for Chintrala china clay was granted to Mr. Nathoo Lalji in 1916, but he did not attempt any serious mining work, and surrendered the lease.

Kaolin or china clay occurs at Kamthana, about 7 miles S.W. of Bidar on the Bidar laterite plateau, where the clay is being quarried and sold as "Kadi." The method of extracting the clay is by sinking a series of pits $2\frac{1}{2}$ ft. square to a depth of about 28ft. through the laterite capping, separated by about 30 ft. from each other. The pits are connected with one another by tunnels 3 ft. wide with intermediate cross-cuts. This kaolin assays as follows :—

H_2O	15.2
SiO_2	44.2
Fe_2O_3 ..	Trace
Al_2O_3.. ..	40.2
CaO	0.2

The kaolin is of good quality and compares favourably with the best foreign china clay. This clay is now being used as a filler for paper in the Sirpur Paper Mills.

About $\frac{1}{2}$ a mile to the south-east of *Srirangapur*, Pargi taluq, highly decomposed pegmatite-granites have given rise to kaolin clay deposit about $1\frac{1}{2}'$ thick in a *nullah* section at margin of chert beds of the Deccan trap formation.

Similar occurrence of kaolin clay was also noted about 2 miles to the east of Kundrug, Pargi taluq, at the margin of the Deccan trap flows.

A small deposit of white clay occurs associated with phyllites about one mile S.S.E. of Maddagudem, Narsampet taluq, Warangal district.

Small quantities of china clay are found associated with phyllites at Miryalpenta in Yellandu taluq.

(*b*) *Fireclay.*

Heat-resisting clays suitable for making fireproof materials are interstratified with the coal beds of the Barakar series. Reddish fireclay is found as a bedded deposit overlying the coal in the hills south of Antargaon in the *nullah* sections below the red clays of the Kamthis, near the border of Sirpur and Rajura taluqs. Fireclay has been reported by Voysey from Konasamudram, Nizamabad district. This clay was used for building furnaces and making crucibles for steel manufacture by the old iron smelters. The clay is reported to be highly refractory.

Pachgaon Fireclay.—The Pachgaon clay deposit is a bed in the upper Gondwanas (Kota-Maleri group) about a mile south of Pachgaon, *i.e.*, 4 miles N.E. of Asifabad Railway Station. The bed is found over an area of about a square mile with a thickness up to 6 feet. In colour the clay is pale gray to pale pink and smooth, even-grained and free from grit. The

clay is used for making bricks, pipes, tiles, etc., and its fire-resisting quality is under investigation for high temperature conditions. The Chief Chemist says the clay is to be classed among good quality fire-clays.

(*c*) *Fuller's Earth.*

Near Kudhalli, Chime Idlai, Peddamal, Gingurti and Kiroli in Chincholi taluq, a fairly large quantity of fuller's earth occurs in beds, and is reported to be useful for oil refining.

Fuller's earth, formerly used in filling cloth, has the property of absorbing greasy matter. Now it is much used as an ingredient of soap and as a cleaning agent in refining oil.

(*d*) *Brick Earth and Potter's Clay.*

Poor quality brick-earth is widely distributed. The bricks made therefrom are generally poor in strength and durability. Good quality brick is however, obtained from Sarunagar and Golconda, which partly meets the demand from Hyderabad. Bricks are also made near Bhongir. The ordinary clay and silt found in the vicinity of villages are largely utilised by the potters and brickmakers for local purposes. Good quality deposits of clay slit for the potter has been noted at Upal Mailawaram, Kotalapuram, Amjapur, Balapur, *etc.*, in Atraf-i-Balda and near Bhongir, which is noted for its pottery. In the neighbourhood of Mallur and Tirth in Surapur taluq, Bhima shales are extensively used for pottery, which is highly prized.

(*e*) *Other Clays.*

Lithomargic Clay.—Extensive deposits of red lithomargic clay are often met with under the lateritic cappings and in between the Deccan Trap flows as decomposed material.

Deposits of red lithomargic clay were noted near Wadagaon in Osmanabad taulq, Shiral in Parenda taluq, in southern parts of Ashti taluq, in parts of

Gulbarga and Surapur taluqs, as well as on the Gurumatkal plateau in Yadgir taluq. Lithomargic is also met with near Kondapur in Kamareddi taluq, Nizamabad district. Extensive beds of lithomargic estimated at over 250,000 tons are found in the western parts of Andola taluq at the junction of the Deccan Trap and Bhima shales.

Below the lateritic cap on the Vikarabad-Bidar laterite plateau, clayey products in variegated colours occur in thick layers. Some of them are found to be suitable for oil refining, some for ceramics, while others for the chemical industry such as ferro-alum etc.

VII. ABRASIVES.

1. *Garnet.*

Red alamandine garnets have been reported from Garibpeta, Kakerla, Paloncha, and from localities S.W. of Singareni Collieries in Warangal district, in a zone of garnet-mica-kyanite or staurolite schists. Semi-precious garnets are also found in water-courses draining hilly tracts composed of garnetiferous rocks from which they are derived as detrital products. Abundant garnets in hornblende-granites occupying a wide area in the south-eastern parts of Yellandu and northern parts of Kammamet and Madira taluqs, including the Gobbugurti and Kannigiri hills, have been noted during recent surveys. Detrital garnets found in the fields and streams in these areas can be a source of raw materials for abrasives and the lapidary industry.

The Hyderabad (Deccan) Co. obtained the mining lease in 1929 and worked Khammamet garnet area (Garibpeta area) for some time. The lease was subsequently surrendered as there was no demand for the garnet already mined. About 86,000 lbs. of garnet are now lying unsold in the area. Large quanities of garnets were formerly sent to Madras to be cut into semi-precious stones. The mining has since been in abeyance.

The output and royalty on garnets mined in Khammamet area are given below :—

Output and Royalty on Garnet produced between 1913 *to* 1929.

Year	Output Lbs.	Royalty O.S. Rs. a. p.
1913	13,681	273 9 10
1914	..	..
1915	26,412	528 9 10
1916	44,250	1,091 12 11
1917	..	..
1918	..	..
1919	117,075	3,512 4 0
1920	45,625	1,368 12 0
1921	10,642	319 4 2
1922	..	..
1923	6,250	187 8 0
1924	..	..
1925	..	..
1926	..	..
1927	..	..
1928	15,125	453 12 0
1929	35,538	1,066 3 2

2. *Corundum.*

Fragments of red corundum are reported from the water-courses draining the Kannigiri hills, in Madira taluq, also in the fields near the village of Gobuguru (Gobbugurti),Khammamet taluq, in Warangal district. Emery-like stone was reported from Amrabad, Mahbubnagar district.

Corundum was also noted in Pedagudem and in the surrounding village lands at Timmapur, Lingampalli and in Anvalgudem in the Miryalguda taluq and occurs in stray localities either as weathered-out fragments in the soil or as deposits in the bare rocky stream-beds. With annual renewal of tillage of soil after rains a fresh crop of corundum crystals appears on the surface of the soil. This becomes available to the villagers who are not slow to recognise its utility as a hard abrasive material. The mineral readily finds a market to Nalgonda, Suryapet, Devarkonda and Kalvakurthi taluqs. There is a demand for it with those who work in stone-carving and polishing. Locally it is made into wheels and whetstones for tool-sharpening.

The quantity of corundum available is uncertain and poor. Annaully about 10 to 12 ℔s. of corundum is obtained. No precious variety of corundum, *viz.*, ruby or saphire, of true gem quality with the requisite transparency has hitherto been found.

3. *Kyanite.*

Kyanite occurs in garnetiferous rocks near Garibpet and Kakerla in Yellandu taluq. In quantity it is much less than the garnet and is picked up as detrital products in the fields and *nullahs*.

4. *Staurolite and andalusite.*

Staurolite occurs scattered about the village lands of Pirampalli and Lachaguda in Yellandu taluq weathered out of the mica-staurolite phyllites.

Andalusite occurs in phyllite as a narrow band about 8 miles long and two furlongs wide between Mulkalpalle and Dandigundal in Yellandu taluq. A fairly large quantity weathers out as surface spreads in this area.

VIII. BUILDING STONES.

The many historic edifices, forts, temples, mosques and mausoleums; *etc.*, are standing monuments to the quality, durability, beauty and variety of the building stones with which the State abounds. The Lingampalli granite near Hyderabad proved superior to Aberdeen granite and was exclusively used for Bombay Harbour construction. The granites of Munirabad and at Raichur are of exceptional quality for heavy construction. The world-famous caves and rock-cut temples of Ellora and Ajanta have been chiselled out from solid trap rocks and stood the ravages of time. The variegated colour of granites and gneisses, the decorative value of porphyritic granites, red syenites, banded gneisses, the coloured sandstones and limestones of the Purana and the Gondwana formations, the red and black trap rocks and the laterites, supply unlimited resources for building materials. The building stones of the State may be broadly classified as follows :—

1. *Dharwar Building Stones.*

The trappoid schists and epidiorites of the Dharwars in Raichur and Gulbarga districts afford hard durable stones for building purposes. At the marginal zone of contact with granite, the Dharwar schists give rise to hybrid rocks of varied patterns of dark and light coloured bands, which could be used as decorative stones. Some of them are so fine-grained and hard that they take a good polish. Such types are met with particularly in the Lingsugur area bordering the Muski-Hutti band, and between the 16th and 20th mile-stone on the Lingsugur-Tavargeri road, and also in the Kalmalli, Kallur and Gabur areas in Raichur district.

2. *Peninsular Granites.*

The rocks of the Peninsular Complex yield building material of varied types both for massive construction and for decorative purposes. Huge slabs and pillars even 30 ft. to 40 ft. long are not uncommon in the temples of the Deccan.

Granite slabs are quarried at Rampur and Raichur. In Manvi, between Boyalmerchaid and Nirmanvi, some quarries yield long pillars. The Satpahar hills in Gangawati, Mudgal, Masarkal and Gabur in Deodrug taluq, are a few of the instances where extensive quarrying is being carried on even to-day. The Baragaz Pahar about 2 miles from Mudgal is said to have yielded the material for Mudgal Fort in which pillars of about 30 to 40 ft. high have been used. One of the old quarries exposes a face 40 ft. in length, 15 ft. in depth from which pillars were cut ; partially worked stones are still seen lying in the vicinity. Lingampalli and various other quarries near Hyderabad have long been known to yield excellent building material.

3. *Limestones.*

Limestones play an important role in modern industry such as cement, iron-smelting and the chemical industry.

This State is well placed with regard to this commodity. A large part of these limestones are situated in proximity to railways. Others which are in the interior have to await better transport facilities for their development.

Limestone areas.—Broadly speaking, four important limestone belts traverse the State.

1. The first belt occupies the Kistna basin bordering parts of the southern boundary of the

State. The limestone of the Kurnool series occur in Alampur taluq and Jatpol Samasthan, up to near Kolhapur where they disappear. Limestones of the Palnad group come in near Advi Devalpalli, in Miryalguda taluq, after a gap of more than 60 miles. They then continue *via* Wazirabad to spread out in Huzurnagar taluq, where they are traced up to near Jaggayyapet in British territory.

2. The second belt of limestones occurs in the Bhima Series occupying a wide area in the Bhima and the upper Kistna basin of the Gulbarga district in Surapur, Andola, Gulbarga, Shahpur and Yadgir taluqs.

3. A third belt of limestones lies along the north-eastern border of the State along the Penganga and the Wardha valleys, Asifabad district.

4. Broken bands of crystalline limestones, sometimes dolomitic, occur as a long narrow belt extending northwards from Yerrupalem and Bonakallu in Madira taluq in the southern border of the State, east of Khammamet, Jestaipalli, Monditog and further north in Yellandu taluq of Warangal district.

(1) *Limestones of the Kistna Basin.*

The limestones of the Kistna basin occur extensively as massive or flaggy beds, of considerable thickness. They are of various colours such as grey, bluish, yellow, black, purplish and olive green.

The $CaCO_3$ content of these varies from 76 per cent. to 87 per cent. with magnesium carbonate in slight traces.

Investigation of the Wazirabad-Medlacheruvu areas to ascertain the suitability of the limestones for the cement industry has revealed that almost inexhaustible quantities of the required quality of limestones and shales are available.

They are not developed in the absence of transport facilities.

(2) *Limestones of the Bhima Basin.*

The limestones of the Bhima basin occupy an area of over 600 square miles with an average thickness of about 300 ft. They consist of both massive and flaggy beds and are extensively quarried for flags where facilities for railway transport exist and find a wide market both inside and outside the Dominions. They are of various colours—light grey, blue, yellow, red, purple and black, and take a fine polish.

In some localities, like Rajan kollur in Surapur taluq of Gulbarga district, lithographic stones are also found.

The Cement Works at Shahabad get their supply of limestones and shale from quarries in the vicinity in the Bhima Series.

(3) *Limestones of the Penganga-Wardha Basin.*

Extensive spreads of limestones interbedded with shales occur in the Penganga-Wardha basin. They are mostly used for construction. Their suitability for the manufacture of cement and as a flux in the iron industry may be investigated when a scheme for the initiation of such industries in the area is contemplated.

The Purana series of rocks yield unlimited supply of limestones both as massive varieties and as flags well suited for constructional purposes. The different shades of colour like black, grey and lilac, yield decorative materials. The grey variety of limestone is by far the most extensive in occurrence and has mainly been used for flooring and ceiling. Extensive quarrying for flagstones is carried on in Shahabad,

Wadi, Chitapur, Tandur, Seram and other places in Gulbarga district, as well as in parts of Adilabad and in the southern parts of Nalgonda and Mahbubnagar districts. Most of these quarries are leased out and are in the hands of private bodies and individuals paying fixed royalty which adds considerably to the revenue under mines.

The black limestones of Surapur taluq near Kolihal and in parts of Seram, Kodangal and Chincholi taluqs and of the Asifabad district, occur extensively and give a pleasing effect when polished. From south of Farukabad in Mahbubnagar district a bright brick-red variety of laminated limestone is reported. A brown variety of limestone is reported from north of Adilabad. Near Wazirabad, Miryalguda taluq, Nalgonda district, variegated and multi-coloured limestones are extensively met with. On the Madras side of the Kistna river similar lime-stones are quarried and many novel articles like paper-weights. tablets, table-tops, *etc.*, are being made and marketed. Yellow limestone is found near Nalwar, Gulbarga district.

There are over thirty quarries working for limestone in Gulbarga and Asifabad districts. There has been a steaby demand for the limestones (flagstones) for house-building and pavement purposes. But of late the demand for those is less as cement is now largely taking their place. Cement tiles are substituted for Shahabad stones for flooring and other uses.

The output and royalty statement for Shahabad stones quarried in the State are given in Appendix 'K'.

4. *Marble.*

Limestones (Marble) of the Bonakallu-Yellandu belt.

Highly metamorphosed crystalline limestones (marble) associated with phyllites and quartzites

occur in the discontinuous bands and patches in the south, in Madira taluq. These bands gradually widen out northwards in Yellandu taluq where they vary in width from a few feet to as much as a mile and run persistently for a few miles. They vary in texture from very fine to medium grain and in colour from pure white to grey, yellow and black. Some of the varieties show bandings in variegated colours and are of great beauty when polished. A large quantity of marble is available in this area. It is quarried both at Monditog and Jestaipalli, at the former place for flooring and decorative purposes and at the latter for lime.

There is scope for developing the marble industry in the State. The marbles of Monditog find a ready market in Bombay and other places outside the State. Similarly "marble lime" is also finding a ready market in view of the several properties claimed for it.

Lime is burnt from marble quarried near Jestaipalli village, Yellandu taluq, Warangal district and is claimed to be of high value with regard to porosity, adhesive qualities and absence of deteriorative matter.

The marbles vary in composition from pure calcite to dolomitic types.

Marble	$CaCO_3$ per cent.	$MgCO_3$ per cent.	Silica per cent.	Total
Grey ..	75.8	21.6	2.6	100
Yellow ..	78.1	21.2	0.7	100
White ..	96.7	2.5	0.8	100

Marble is quarried at Monditog, near Yellandu, Jestaipalli, and Raghunathapalem areas in Warangal

district. A mining lease for marble in Jestaipalli, Monditog and Raghunathapalem areas was issued to the Deccan Marble and Mining Co. Ltd., in 1936. This company has since been quarrying marble at Monditog and preparing marble lime in Jestaipalli area. Flooring tiles, table-tops, and other decorative articles are made from the marbles which find a ready market both in and outside the State. There is a great scope for developing this industry and there is a very large quantity of marble in various colours and patterns available in Warangal district.

In the Sangora bank of the Wardha river in Rajura taluq highly crystalline limestone approaching marble has been noted.

The statement, Appendix 'L', gives the output and Royalty on marble quarried and marble lime produced from 1934-1938.

5. *Sandstones.*

Pink, gray and buff sandstones of varying grades of texture are extensively developed in the Purana rocks as well as in the Gondwanas. The iron-free Barakar and Kamthi sandstones are used in Rajura, Chinnur and other taluqs in Asifabad district.

6. *Slates.*

Strictly speaking, there are no true slates so far seen although a considerable quantity of hardened shales are available about a mile to the north of the confluence of the Musi and the Kistna rivers, near Wazirabad, Miryalguda taluq, Nalgonda district. The stone can be sawn into 'slates' and used for paving, shelving tables, *etc.* The stone is fine and even-grained, darkish, indurated shales or flagstones splitting evenly along the bedding-planes. It is also suitable for the production of roofing 'slates,' class

room-boards and writing slates. The stone is rather soft for use as paving but appears to be weather-resisting.

Indurated black shales splitting into thin slabs may possibly be found suitable for the manufacture of 'slates' in the following localities :—

Gulbarga district (Andola taluq).

(*a*) Village Maradgi. Two wells recently excavated expose indurated beds with smooth surface, break into fissile shales.

(*b*) Gudur : Two ryot wells excavated expose thin indurated calcareous fissile shales to a depth of about 18′ from surface.

(*c*) *Chennur* :—The Darga hillock about 2 furlongs N.W. of Chennur village exposes black indurated shales splitting into thin layers suitable for making school 'slates.'

(*d*) At Jainapur in the well excavated by the Well Sinking Department hard black calcareous shales occur in beds about 30′ in thickness, splitting into thin layers with smooth surfaces.

All these villages are situated at a distance of 2 to 4 miles from the Yadgiri—Jawargi road within a radius of 4 miles from Janapur, the central village of the group.

Good slates with smooth faces splitting into thin layers are found in several areas in Yellandu taluq fringing the marble bands. At Tumalchilka a lease has recently been given for quarrying slates.

7. *Trap rocks and Laterite.*

Good building materials are easily obtained from Deccan Trap areas where hard fine-grained varieties are particularly suitable. Basaltic and porphyritic

flows yield decorative varieties. The red varieties form excellent decorative stones. The black and red varieties are used for floral designs in the Mausoleum-Bibika Maqbara, Aurangabad.

The laterites of the Vikarabad—Bidar plateau are cut into blocks of suitable sizes for construction.

8. *Lime Kankar.*

Secondary nodular lime *kankar* is widely distributed throughout the State over almost all geological formations, upon the Dharwars, granites, Deccan Traps and limestones. They produce, on burning, lime well suited for constructional purposes. A deposit near Zupalli about 8 miles east of Kalvakurti on the Jadcherla-Devarkonda road is being utilised for the supply of lime in the Gundlapalli construction work (Dindi project). About a mile south of Girikottapalli, a kankar bed about 40′ thick is seen in well sections.

Some of the other more important lime kankar occurrences are given below :—

(1) Near Anjapur and Tarnur on the Hyderabad Ibrahimpatan road.

(2) To the west of Gandipet on the road to Vikarabad.

(3) Intertrappean beds in the Vikarabad area.

(4) Sindhnur-Koratgi-Gangawati area in Raichur district as subsoil beds.

(5) Kembhavi and Wajal areas in Surapur taluq of Gulbarga district (Calcareous tufa).

(6) Gurmatkal area in Gulbarga district.

(7) Between Bonakallu and Yerrupalem in Madira taluq of Warangal district.

(8) Kankar occurs at the junction zones of limestone beds, and as overlying spreads on quartzitic sandstones in Damarcherla, Advi Devalpalli and Viralapalem in the Miryalguda taluq.

IX. SPRINGS AND MINERAL WATERS.

Along the margin of the Chikiala range in Sirpur taluq, Asifabad district, many natural springs were noted at the junction of sandstones and clay beds, the notable among them being near Bijapur and Hutpalli.

At the contact of the shales and limestones of the Bhima series, in Surapur taluq, natural springs occur which feed some perennial streams. At Wajal and Mudanoor perennial warm mineral water springs with copious discharge have been noted. The water is insipid in taste. At Buga in Warangal district a hot spring, with a temperature of 110°F., forms a pool $40' \times 30'$ and about $5'$ deep but the discharge is small. Hot springs are also noted at Unkeshwar, Kinwat taluq, Asifabad district. These springs are well known for their medicinal properties.

At the junction of the Dharwar schists and gneisses perennial springs are common. Such springs are seen at Pamankallur, Hira, Chikbergi, Tadgi, etc., in the Raichur Doab.

Near the Saadet Ali Darga at Bidar, a perennial luke-warm spring issues at the contact of the hard trap and the upper lateritic cap. Water from this spring is said to have tonic properties.

X. WATERFALLS.

With large rivers like the Godavari,* Kistna, Tungabhadra, Manjra, flowing through the State,

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**Vide* " Hydro-Electric Power from the Godavari River " by Nawab Ahsan Yar Jung Bahadur, Institution of Engineers India) Hyderabad-Deccan.

the economic possibilities of hydro-electric schemes may not be lost sight of. The Jaldrug falls have been made famous by Col. Meadows Taylor in his "Noble Queen." This has a total fall of about 140 ft. distributed over a distance of about a mile and a half, with a number of small cascades, the biggest of which has a vertical fall of about 60 ft. The Gollapalli falls in Gurgunta Samasthan in Raichur, descends in two stages a vertical height of 97 ft.

The Southada falls in Bir district on a tributary of the Sena river have a considerable catchment within the State limits and descend vertically about 230 ft., at the scarp of the Deccan Trap plateau, in a 'V' shaped valley. Below the fall, the river flows for about a mile in this State before it enters Jamkhed taluq in Ahmednagar district. Except for about two months in the dry season, the stream is said to have a surface flow. With a dam raised to about 50 ft. near the escarpment, the flow of the stream at a uniform rate may be maintained throughout the year. The conditions are ideal for an hydro-electric scheme and the excess of power generated might be sold to the mills in the British India districts.

A perennial stream rising in the Deccan Trap tableland, gives rise to a fall of about 80 ft. in the gneissic country about a mile to the south-east of Gurmatkal. This water may well be regulated for a suitable hydro-electric installation to provide power to the taluqs and particularly to Narayanpet which is a growing commercial centre about 10 miles from the site of the falls.

A vertical fall of about 15 ft. is noted at Chennur, on the Hunsgi *nullah*, which is perennial.

In Yelgudup taluq, Asifabad district a vertical drop of about 120 ft. on the Kadam river is a possible site for a hydro-electric scheme.

A minor fall has been noted at Wajia in Kinwat taluq with a drop of 25 ft.

Picturesque waterfalls lend charm to the wilds of the Aurangabad trappean plateau, particularly near Ajanta.

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APPENDIX 'K.'

Output and Income from Quarries from 1325-1350 *F.*

Year	Output in sq. ft.	Income		
		O.S. Rs.	as.	ps.
1325 Fasli ..	1,075,031	19,807	8	9
1326 ,, ..	1,525,711	20,117	14	5
1327 ,, ..	3,046,906	23,017	2	0
1328 ,, ..	3,112,000	21,312	7	0
1329 ,, ..	3,225,293	23,037	13	5
1330 ,, ..	3,909,240	24,422	7	8
1331 ,, ..	3,786,847	29,127	13	10
1332 ,, ..	3,833,412	28,048	2	9
1333 ,, ..	4,265,831	29,068	11	3
1334 ,, ..	4,198,541	29,883	9	8
1335 ,, ..	3,942,143	28,415	7	10
1336 ,, ..	4,032,310	33,762	10	9
1337 ,, ..	4,288,527	34,112	15	10
1338 ,, ..	3,063,018	32,126	7	1
1339 ,, ..	2,987,746	32,297	4	2
1340 ,, ..	2,949,558	30,885	14	6
1341 ,, ..	3,135,987	33,084	14	6
1342 ,, ..	3,350,123	31,813	15	0
1343 ,, ..	3,231,637	36,530	0	2
1344 ,, ..	3,685,290	34,414	8	7
1345 ,, ..	2,953,931	31,298	15	7
1346 ,, ..	3,301,637	29,397	1	3
1347 ,, ..	3,468,108	36,748	4	9
1348 ,, ..	3,830,806	39,664	9	0
1349 ,, ..	2,785,000	29,878	11	5
1350 ,, ..	2,390,000	27,447	13	2

APPENDIX 'L.'

Statement of Output and Royalty on Marble quarried and Marble Lime produced and Moditog and Jastaipalli since 1934.

Year	Jestaipalli		Mondi-marble	Total marble	Total lime	Royalty at Rs. 2 per ton
	Marble	Lime				
	T. C.	T. C.	T. C.	T. C.	T. C.	Rs. as. ps.
1934 ..	79 9	..	..	79 9	..	159 0 0
1935 ..	124 18	22 4	..	124 18	22 4	294 3 2
1936 ..	..	217 18	597 4	597 4	217 18	1,630 3 2
1937 ..	..	322 7	563 7	563 7	322 7	1,771 6 5
1938 ..	..	97 17	483 17	483 17	97 17	1,159 6 5